SCIENTIFIC AMERICAN SUPPLEMENT. No. 1329

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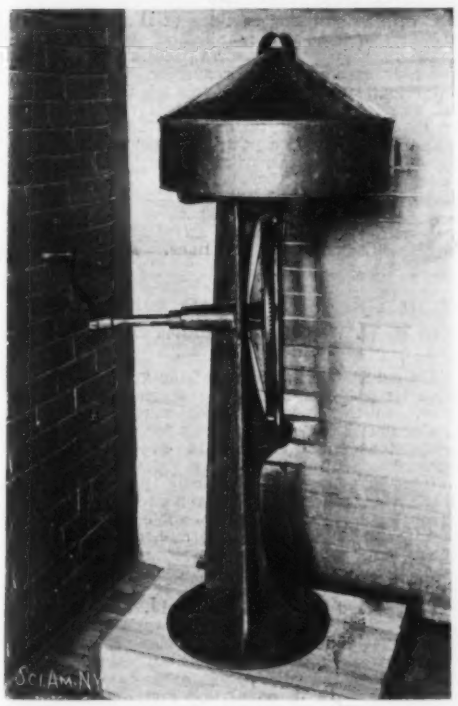
Scientific American. established 1845.
Scientific American Supplement. Vol. LI. No. 1329. NEW YORK, JUNE 22, 1901. Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

WISCONSIN EXPERIMENT STATION.

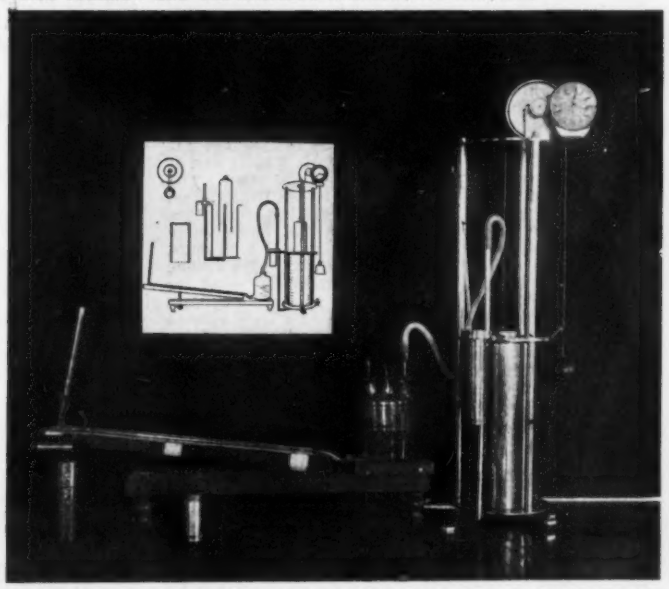
EXPERIMENTAL VINEYARD, GEORGIA STATION, EXPERIMENT, GA.



THE ORIGINAL BABCOCK TEST CENTRIFUGE.

UNITED STATES AGRICULTURAL COLLEGE AND EXPERIMENT STATION, URBANA, ILL.

WING OF BIOLOGICAL LABORATORY, OHIO EXPERIMENT STATION.



APPARATUS FOR DETERMINING THE EFFECTIVE SIZE OF SOIL GRAINS, WISCONSIN EXPERIMENT STATION.

EXPERIMENTAL AGRICULTURAL STATIONS.

SCIENCE AND AGRICULTURAL EXPERIMENT.

By J. A. STEWART.

For the farmer, sciences are being ransacked; and labor and learning are laying their stores at his feet. The application of science to the needs and purposes of agricultural workers has naturally had a retroactive effect. Science, in turn, has been enriched and enlarged by the results of experimental research.

To what extent this has been done is best realized from the records of the work of the experts in scientific inquiry, as represented in the National Department of Agriculture at Washington, and in the network of agricultural experiment stations which extends to all parts of the country. These stations, which have enjoyed such remarkable expansion and usefulness in the last decade, are centers of scientific thought and demonstration. Their investigations, the results of which have been scattered broadcast in printed form, have materially affected farm practice in this country. And it is a significant fact that the more scientific they are, the more they are relied upon by progressive farmers for advice and assistance.

It is an acknowledged fact that the agricultural experiment stations and the agricultural colleges with which they are usually connected have produced an agricultural science for America. They have happily made their contributions to human knowledge a matter of popular comprehension. They have trained special investigators who have made valuable discoveries as a result of their research. The extent of the United States, the variety of its climate and topography, have rendered very wide its range of vegetable production and its opportunity for building up an agricultural science. In the great agricultural changes which have taken place during the last quarter century it must be conceded that the agricultural experiment stations have played not only a most important part by their application of science to local needs in the agricultural arts, but also in their definite and valuable contributions to science itself.

Scientific investigation and experimental work in agriculture, it is pertinent to note, began with scientific investigation in a few lines, carried on chiefly by college professors as supplementary to their regular duties of instruction. When the first station was equipped at Albany by the New York State Agricultural Society, its work related chiefly to the analyses of soils and manures. Its chief equipment was a chemical laboratory and its labors were almost entirely in the interests of chemistry. When the stations were established in connection with the land-grant colleges in 1862, each was given a definite portion of the college farm for its exclusive use. These station farms are generally divided into limited areas on which plat experiments are conducted; horticultural plantations, including vegetables and small bush and orchard fruits; fields devoted to experiments in growing crops on a relatively large scale; fields in which forage crops are grown for use in experiments with silos, the feeding of animals, dairying, etc., and pastures or woodlands. These farms are provided with more or less elaborate systems of drainage, and in many of the States west of the Mississippi River have irrigation ditches with the accompanying water rights.

Each station consists usually of one or two main buildings which contain the executive offices, the chemical, botanical, bacteriological and other laboratories, museums and libraries. In respect to other provisions there is a wide variety. Barns which are utilized for housing live stock, storing grain and forage crops, or are fitted up with special reference to feeding experiments; piggeries, and poultry houses are quite common. At a number of stations there are vegetation houses and buildings set apart for experimental work in dairying. Glass houses in which insects may be bred and their life history studied are unique features at some stations, originating at Cornell University Station. In a similar way provision is now made at a number of stations for the culture and treatment of fungus and other diseases of plants.

Naturally the stations are well equipped with scientific apparatus for work in chemistry, botany, bacteriology and entomology. The work of the stations has led to the rapid increase of scientific apparatus for studies in vegetable physiology and pathology, and agricultural physics, and the invention by station workers of apparatus for special purposes.

Two of these notable inventions are shown in our pictures. The origination of the Babcock test is the most widely known result of the Wisconsin station's work. This is a method for the rapid determination of the percentage of fat in milk. It was devised by the chief chemist, Dr. S. M. Babcock, and the first account of it appeared in July, 1890. Since then the station has issued over 60,000 copies of bulletins and reports in which it is described.

The apparatus for determining the effective size of soil grains consists of a water receptacle; an aspirator bell; an air tube, leading from the bell to the air chamber, and a soil tube provided with a tight cap at one end and a cap with wire gauze at the other. The air-meter is a clock gear, as shown in the illustration. The pressure gage is represented at the left, consisting of a pressure tube connected with the large water receptacle, used to avoid reading the gage at both ends. The pressure is developed by a weight. This unique apparatus, it is held, fully fills the long-felt want for a method of soil examination which shall give definite data regarding the effective surface of a unit volume of soil, both for the holding of soil moisture and for the solution of plant food; and to show whether or not the grouping of soil grains in a virgin soil is fundamentally different from what it is in the same soil after it has been long under cultivation.

Large collections of specimens have been made in some instances by the experiment stations.

It is a fact not to be gainsaid that the problems of agriculture furnish adequate opportunity for the exercise of the most thorough scientific attainments and the highest ability to penetrate the mysteries of nature. The work of compilation undertaken by the station experts preliminary to entering upon distinctively scientific research was necessary in order to supply both farmers and experimenters with the essential data, and to lay the substructure for the later scientific work. The work, as has been stated, brought to the front groups of trained scientific experts whose investigations have involved many original discoveries in physics, chemistry, botany, zoology, entomology, geology, meteorology, agronomy (plant production), horticulture, forestry, physiology (of man and domestic animals), zoötechny (animal industry), veterinary science, agrotechny (agricultural technology), and rural engineering.

The stations are at present conducting a wide range of scientific research in the laboratory and plant house, and an equally large amount of practical experimenting in the field, the orchard, stable and dairy. Among the most important scientific investigations have been those along the line of economic entomology. This has produced additions to our knowledge of many beneficial and injurious insects, including in many cases the completion of their life histories; studies in the breeding of insects, especially as a means of their investigation; the discovery or invention of methods and appliances for the repression of injurious insects, and for the study of insects. Among the insects on which the station entomologists have made extensive studies resulting in the development of effective methods for their repression are the codling moth, plum curculio, scale insects, chinch bug, Rocky Mountain locust, woolly aphis, cotton worm, boll weevil, forest insects, and insects affecting stored grain. Systematic studies have also been made in other lines of zoology, especially of such injurious mammals as gophers and rabbits, and of useful and injurious birds. There have also been contributions to the life history and culture of oysters and the life history of nematodes.

At Cornell Station, N. Y., a root cage has been devised for the observation of subterranean insects. At the Ohio insectary, shown in our illustrations, there is a collection of about 4,000 insects, about one-half of which have been reared and studied at the station.

In agronomy, the introduction of new varieties of crops adapted to special regions or particular economic purposes and the improvement of species by selection and by plant breeding, have been the special features of scientific work. The most notably successful of introduced plants has been the Australian saltbush (*Atriplex semibaccata*). Its value has been demonstrated on the arid and semi-arid lands of the West in an economic way by rendering available for grazing purposes thousands of acres of land hitherto practically worthless. Its success led to the scientific discovery that all upland soils in arid climates contain from 2,000 to 4,000 pounds of alkali per acre without giving any visible indication of it. The culture of cotton has been the subject of scientific investigations in the South, where years of continuous cotton production have impoverished the soil—a study which has led to important experiments in soil inoculation and the value of certain soil micro-organisms for the successful growth of leguminous plants.

Exceedingly important contributions to science have been made in the physiological studies in nutrition in which 14 stations have engaged and in which very little experimental work had previously been done either in this country or in Europe. From the scientific standpoint, the respiration calorimeter, devised at the Connecticut station is most important, as it has revolutionized the means by which the study of the application of the laws of conservation of matter and energy in the human body can be carried out to a completeness never before attained. This apparatus, it is pleasant for American scientists to note, has obtained recognition abroad, the Prussian government having ordered a similar apparatus for the Institute of Animal Physiology at Bonn, under Prof. Hagemann; and one has also been constructed for a similar institute at Budapest under Prof. Tangl.

In agrotechny, twenty-nine stations (including Illinois and Wisconsin, whose fine buildings we show), are making chemical and bacteriological studies of milk and dairy products exceedingly valuable, both from the standpoint of pure science and practical utility. For instance, the result of extended feeding experiments has shown that a safe standard ration for a normal dairy cow, producing 1.2 pounds of butter fat daily and weighing approximately 1,000 pounds, was 2.06 pounds protein, 12.5 pounds carbohydrates, and 0.89 pound fat per day. A method for counting and measuring fat globules in milk and an apparatus for determining the viscosity of milk have been devised at the New York station. The investigations into the extent and character of milk infection with micro-organisms; pasteurization; the use of pure or of definite cultures in butter-making and cheese-making; the nature of the changes in the ripening of cheese and the kinds of organisms causing them have contributed important additions to bacteriological information. The working of these problems has led to the discovery of a ferment in milk hitherto unknown, which is believed to play a very important part in cheese ripening. Another notable contribution to botanical bacteriology has been the demonstration of the nature of pear blight, one of the most destructive diseases of apples, pears and kindred fruits.

Not only bacteriology, but vegetable physiology and pathology, have reaped large accessions from the work of the stations in botany. Through the work on plant diseases mycology has been enriched. Important contributions have been made to our knowledge of pruniculous Exosaceæ of the United States. Research brought to light some undescribed species and several European ones not heretofore known to exist in this country. Investigations on the diseases of forest trees have been in progress for some time and connected therewith have been studies on the development of certain trees with a view to determining the rate of growth, distribution and fertility of seed, as well as the conditions which influence or modify the life of these trees. Various pyrenomycetes have been studied with a view to tracing their development and polymorphy and to ascertaining the relationship of certain pycuideal and conidial forms. A greenhouse pest (*Aleurodes vaporariorium*) was first reported from the United States. Original analyses made in the chemical laboratories of the stations have added largely to the scientific knowledge of economic plant foods, dairy products, fertilizers and other agricultural materials. Among the purely chemical investigations have been the isolation of the different proteids of seeds and cereals and their examination as to elementary composition and properties; studies of the development of the constituents of wheat during the growth of the plant; investigation of the constituents of the nitrogen-free extract of feeding-stuffs; and systematic chemical studies of staple crops, such as maize, cotton, alfalfa.

Among the horticultural investigations which are of most interest in their practical as well as scientific aspect are those relating to the introduction of new kinds and varieties of fruits in different localities and the increase in hardiness through grafting. Experimental vineyards such as that of Georgia in our illustration are common. The introduction and testing of useful trees has resulted in a broader knowledge of the habits of many useful species from Chile, South Africa, Austria, Algeria, etc.

In testing varieties of vegetables and small fruits, and in making studies in varietal improvement and synonymy, the stations have aided materially in building up horticultural science. The special studies of problems relating to meteorological phenomena and climatic conditions have resulted in additional data of great value to meterological science.

For purposes of verification or demonstration one cannot lose sight of the fact that material aid has been rendered by the thousands of co-operative agricultural experiments now annually carried on in the United States in which farmers take part. For these the station usually furnishes the plans of work, and the seeds, fertilizers, fungicides or other materials required, and also makes the chemical or other examinations of the soils, fertilizers or crops necessary to determine the data or results sought in the experiment. The farmer on his part furnishes the land, orchards, labor, etc., most commonly without charge.

In order that the farmers, who otherwise might be unfamiliar with the results of agricultural investigation, might the better understand what the stations are doing, it has been found necessary to issue publications giving them the complete information. In this way there has been built up a literature of agricultural science for America which did not exist a few years ago. The relation of this work of publication to the promotion of agricultural science is understood when it is known that it includes abstracts of the bulletins and annual reports of our stations, the publications of the United States Department of Agriculture, books, journals, and miscellaneous publications containing reports of investigations in agricultural science in different countries of the world; special articles by American and foreign experts in agricultural science; editorials on important matters regarding the progress of agricultural education and science, with suggestions of lines of inquiry for our stations, and notes on the organization, equipment, and development of institutions for agricultural education and research at home and abroad.

By the application of science to agriculture, and by the aid of scientific research, it is believed with good reason that the agricultural arts will enjoy a renaissance and be lifted into a position of permanent popularity and financial prosperity among the industries of America. On the other hand, the effect of agricultural education and research has been to give an impetus to general science and to attract to agricultural science the respect and attention of scientists and educators engaged in other lines.

POSSIBILITIES OF AMERICAN AGRICULTURE.

By Prof. H. W. WILEY, of the United States Agricultural Department.

THE United States, in respect of the great industries in which its people are engaged, is essentially a food producer. In this term, however, must be included the production of the raw materials for clothing, since the production of food and clothing are the two great branches of agricultural industry.

It is true that our country, during the last decades, has made wonderful progress in manufacturing, but this progress has been made possible because agricultural products are abundant and cheap. While, therefore, we pay our laborers more per man per day than is paid in any other country, we get a higher return for the investment. It is a truth universally conceded that the best paid, best fed and best clothed laborer gives the best work, so that, in reality, it is doubtful whether, measured by the amount of work produced, American labor is any higher paid than the labor of any other country.

Our rapid growth in population and the continued demands made upon us by other countries for agricultural products, have naturally raised the question whether this country in the future will be able to meet the demand made upon it from the agricultural side. We are feeding now nearly eighty millions of people within the boundaries of our own country, and sending enough material abroad to clothe and feed an almost equal number. Our foreign markets for agricultural products are the great source of wealth and preserve for us the favorable balance of trade which determines whether a nation is growing richer or poorer. The economic question, therefore, of preserving these foreign markets appears to be one of the highest import.

The statistician looks forward a few years and sees our population doubled. If, during that time, no great advance is made in agriculture, it is evident that all the products of our fields will be needed at home and we will no longer be receiving the tribute from foreign countries for these products which has made us such a wealthy nation. It is the part of wisdom, therefore, to forecast the possibilities of American agriculture, and see what relation it will bear to the progress of our country in population and industries.

In the first place, attention should be called to the fact that no country in the world has so richly endowed agricultural research as the United States. For the support of agricultural experiment stations in the various States and Territories of the United States and for Hawaii and Porto Rico the Congress of the United States appropriates annually $789,000. In addition to this Congress has endowed agricultural colleges in every State and Territory, and these endowments, together with the buildings, apparatus, machinery, libraries and miscellaneous equipment, represents a total of $53,632,852.25. The total income of these institutions annually is $6,008,379.20, of which amount there is given annually by direct grant of

Congress $1,108,610.38. These colleges contained at the end of last year 31,658 students, of whom 4,181 were taking the special courses in agriculture.

These statistics show that the United States, so far as agricultural education and research can go, is providing for the future in the most abundant way.

It is true that when people speak of agricultural research and agricultural education they are accustomed to refer still to what Europe has accomplished. There is no denying the fact that in the past Europe took the lead in agricultural education and research, but Europe has already been overtaken and far outstripped by this country. The practical effects of this educational work are already shown. The establishment of so many centers of experimental agriculture shows the road to an increased production by an actual demonstration or object lesson, pointing out the methods not only in a theoretical way, but also in a practical way.

It is evident that practically all the lands suitable for agriculture in the United States have been taken up. Hence, the increase in agricultural production will no longer be secured, as heretofore, by extending the area under cultivation. The only extension of this kind, of any considerable magnitude, which the future gives promise of, is in the reclamation of the arid lands of our country. When, by the best engineering skill, all the available water of the arid regions is placed under tribute and conducted over the areas where it can be profitably employed, we may see many millions of acres of very fertile soils added to the areas now available for agricultural purposes. But even the utmost possible expansion in this direction will not be able to keep pace with our growth in population and our industrial effort. Where, then, we may ask, is the increased agricultural production to be found? In answer to this question it may be said first, that our system of agriculture will then be radically changed. Heretofore, we have devoted vast areas to grazing, and thus our production of domesticated animals has been larger in proportion to our population than that of any other country. But it is evident that where two or three acres are necessary for the grazing of a single animal, the number of farm animals must diminish when the land is occupied for other purposes.

It has been demonstrated by careful experiments in agricultural stations that a farm animal can be kept in good condition on one-tenth of the area which would be necessary if open grazing were practised. It is plain from this that the days of large pastures, cattle ranges and open grazing have passed, and domesticated animals must be fed by intensive culture of smaller areas where immensely greater quantities of cattle feed can be produced than is furnished by the richest pastures when kept closely cropped by continual grazing.

Attention should be called also to the fact that green cattle foods can be preserved in a state almost as valuable as at the time of production by means of the silo. Large quantities of sugar and other nutritious foods are produced in the stalks of Indian corn and sorghum and other green forage crops. If these crops are cured or dried, all, or at least a part of the sugar ferments and is lost as food. Preserved in the silo, however, the fermentation is superficial, and the greater part of this valuable material is made available.

But even in the case of dried foods, there is an immense waste of valuable matter, because these foods are not in a condition for mastication and digestion. A single instance will suffice to illustrate this point. The dried stalks of Indian corn, which have long been regarded as a nuisance in our country, contain large quantities of valuable cattle food which is available if the stalks be reduced, by mechanical means, to a fine state of subdivision. By the greater production of food stuffs on circumscribed areas, and by the more perfect utilization of the waste products, at least those which have heretofore been considered so, the number of domesticated animals can be vastly increased, and thus this source of food supply is not likely soon to be exhausted.

In the second place, the product of the fields by direct cultivation can be increased to an almost indefinite extent by scientific cultivation and fertilization. The great lessons which experimental agriculture has taught so far have been the utility of good culture and the necessity of proper fertilization. The field must be fed just the same as the man or the steer in order to secure its best results. Impoverished fields always show either ignorance on the part of the farmer or inability to supply proper food for the soil. Agricultural chemistry has pointed out the sources of soil exhaustion. It has shown what valuable plant foods are removed by the crops and how much of them is taken away by rains and winds. Scientific argiculture shows the way to avoid these losses and even to restore exhausted fields to their former state of fertility.

Agricultural statistics show that the average yield of wheat per acre in the United States is a little less than thirteen bushels and that of Indian corn a little less than twenty-seven bushels. Already the results of the studies of the needs of the soil and of the crop have led to the production of not less than forty bushels of wheat per acre on fields which, without proper treatment, yielded less than ten. The yield of Indian corn has been, with but slight expense after the nature of the soil has been understood, increased from thirty bushels to more than eighty bushels per acre. These are only illustrations of what the possibilities of agriculture may be in the future.

The conservation of plant food and its return to the soil is not only a duty of the farmer but a necessity of agriculture. It is not necessary that the farmer should create elements of soil fertility. He is only asked to preserve that which Nature has given him, and if, by improper methods, those elements have been removed from his fields, to see that they are restored and preserved.

In the third place, the possibilities of agriculture in the future will show a wiser selection of localities in the production of crops. Heretofore, agriculture has been, we may say, of a general nature. In the future it will be specialized. The facilities of transportation have now become so great as to demand that that product which is peculiarly suited to the soil and climate be produced and exchanged for other products better suited to other localities.

This does not mean that diversified farming should be given up, but it means that diversity should be specialized. There is scarcely a farm in the United States which is complete without at least a few fruit trees, but to grow peaches or apples for the market in localities not suited thereto will only lead to bankruptcy. Where fruits are to be produced for commercial purposes, localities must be selected best suited for their production. Thus the peach orchards, apple orchards and pear orchards of the country will gradually be collected into areas where soil and climate are most propitious. The same remark may be applied to the production of cereals of all kinds, and to small fruits and vegetables.

Of course, proximity to large cities and large markets alters, to a certain extent, natural conditions, for in that case the proximity of the field has much to do with the profits of the farm. There are hundreds of localities in the United States as well or better suited to the production of vegetables than the farms of Long Island or the sandy fields of New Jersey, but because these farms are near large markets it is found extremely profitable to produce upon them a great variety of food products. But aside from these local conditions, the general principle holds true that the great staple products of the country will be produced more and more in circumscribed areas. Particularly is this true of sugar, which is one of the prime articles of human food. The sugar beet is particularly affected by soil and climate, and therefore its successful production will be confined to areas specially suited to it. It has been found that, as a rule, the irrigated lands of the arid regions are well suited to the production of beets of a high content of sugar, and it is more than likely that the near future will see a large portion of the sugar consumed in the United States produced upon lands which are now untilled for lack of water.

To sum up the subject, it may be said in regard to the possibilities of American agriculture, that the scientific farmer of the future will be ready to meet all demands which may be made upon him by increased population and multiplication of industries. —The Christian Work.

TRAGEDY OF THE ESKIMO IN ALASKA.*

THE conditions existing throughout the whole Territory of Alaska as regards the physical well-being of the natives are not only deplorable, but appalling, and offer a problem of great difficulty to overcome. During the whole of last year the mortality among these people, always great, was doubled and trebled; whole tribes have succumbed to disease, and many of the settlements have been literally wiped out. It is estimated by the agents of the commercial companies in charge of stores located in all the principal points in the Territory that three-quarters of the entire native population have in that period died. The Alaska Commercial Company, after considering the reports of their representatives, report that not over 6,000 aborigines are now living in all the vast Territory of Alaska.

The Eskimos of the Arctic frontier, as well as those of the Nome Peninsula, St. Michael's, the Yukon Delta and the islands of Bering Sea, Aleutian Archipelago and Peninsula, together with those of the narrow strip of Southeastern Alaska, all without exception have been thus stricken. Weakened by famine and exposure the natives fall easy victims to the encroachments of disease, and unless prompt measures are taken the early obliteration of the most interesting of all native tribes under the protection of the United States will be accomplished in a few years.

In 1880, according to the census of that year, there were living in Alaska 32,996 natives and 430 whites. Of this number, 3,094 were in the extreme north, or Arctic division, 6,870 resided on the Yukon and its tributaries, 8,911 in the Kuskokum division, included in the delta of the Yukon and neighboring islands, 4,352 were about Kadiak, 7,748 in Southeastern Alaska and the balance, 2,451, in the Aleutian district. The census of 1890 gave a total population of the Territory of 32,052; but of this number the whites comprised 4,298 and Chinese 2,288, leaving a total native population of 25,466, indicating a loss of 7,530 in the ten years between 1880 and 1890.

It is remarked that the decrease in numbers of the natives coincides with the increase in the white population of the Territory. In 1880 there were but 430 whites; in 1890 the whites numbered 6,586 (including Mongolians), and in this decade, assuming the census of 1880 to be approximately correct, the decrease of the natives was 7,530. The great mortality among the native population has been known to travelers, but nothing practically, beyond isolated efforts on the part of the churches, has ever been done to arrest the decay of the native tribes. The inaccessibility of the Indian settlements, remote from lines of travel and isolated from the sea by barriers of ice for more than half the year, left them dependent upon their own medicine men, and victims of debased superstition.

The last year, however, has immensely increased travel in the direction of Alaska and compelled the government to add to its fleet in Alaskan waters, each ship having its own physician, who from professional instincts if not from humane motives was compelled to take cognizance of the immense mortality among the natives. Dr. J. J. Murphy, of the U. S. Geodetic and Coast Survey steamship "Pathfinder," which occupied several months in the survey of Norton Sound and Bering Sea, reports, as coming under his own observation, that in a large number of settlements visited by him there was not one whose numbers had not been greatly decreased during the last year, deaths being of daily occurrence. At Skatolik, Unaklaklik, Egowik and Cape Darby, all near Galovin Bay, the deaths in August were four daily in each of the settlements, or sixteen in all, in a population aggregating not over 300. In the Yukon district the mortality was equally great, and everywhere throughout the Territory all reports coincided. At Attu Island, at the extremity of the Aleutian Archipelago, the native population, which in 1875 was 250, had decreased to 90 in 1900.

In the Yukon division, which includes St. Michael, the mortality was very great and the Eskimos terribly destitute. In November last emergency rations were drawn from government vessels and every blanket that could be spared was turned over to the suffering natives. Supplies from this quarter were insufficient and the surplus food, blankets and clothing in the hands of private parties and merchants to the extent of $25,000 were appropriated and given to the natives. Yet the last accounts received are that the plague has not been stayed, the number of deaths have greatly increased since winter closed down and the prospect, with famine, disease and want of shelter for these people during the inclement Arctic winter, is that when spring returns but few of these people will be alive.

The reasons for the wholesale extermination of the Alaskan natives are popularly believed to be due to diseases and habits introduced by the whites, largely to spirituous liquors, of which the natives, like all aborigines, are extravagantly fond; but the whites are not, according to observations of reliable persons, responsible for the recent vast numbers of deaths among these people. Liquor is an expensive luxury in Alaska even at this time, and the efforts of the government to prevent the liquor traffic have been largely effective. Some contraband liquor has undoubtedly reached the natives, but not to any great extent. In fact, the opinion of those who are most competent to judge favors an occasional ration of spirits to the natives. Diseases peculiar to whites and introduced by them do not account for the great diminution of the native population. Dr. Murphy is confident that other causes are responsible, and it is his opinion, expressed with professional reserve, that the Indians are suffering from an epidemic of grippe followed by measles, which has been prevalent throughout the Territory and very fatal. Pneumonia and tuberculosis attacked the natives, already enfeebled, and caused hundreds of deaths. In one party of 13 natives coming under the observation of this physician who camped at Skaktolik, near Galovin Bay, one Sunday in August last, eleven had died by the following Thursday. Neither was this instance a solitary one by any means. While the "Pathfinder" was off Cape Nome all last summer, in every settlement visited the mortality had been great.

In the opinion of Dr. Murphy the principal reason for the great susceptibility of the natives to disease arises from their own ignorance and a general want of thrift among them. Coming in contact with the whites they are eager to imitate and adopt the white man's methods of living. They purchase the food of the whites, but through inexperience in its preparation they only mix an indigestible mess upon which they gorge in the manner peculiar to savages. The change from an inherited diet of fish, blubber and oil is attended with disastrous consequences. They suffer from lack of foresight, inasmuch as they willingly part with their furs to the whites, assuming the latter's garb, and when the cold weather comes upon them consumption and pneumonia attack their insufficiently protected bodies and death soon marks them for its own.

Travelers in Alaska are familiar with the horribly unsanitary and filthy character of the Eskimo dwellings. These harbor twenty or more, who live in darkness except for the dim light shed by a smoking wick; not a breath of fresh air is allowed to enter; built half under ground, with a thick covering of frozen earth, the native passes the winters in idleness and in the indulgence of his bestial passions. The "shacks" are kept heated to boiling point almost, and crowded to the utmost extent, as it is, all breathing air that positively reeks with the horrible odors from their own persons, combined with the effluvia from the rotting stores of their winter's supply of provisions.

The outlook for the Eskimos of Alaska is pitiful, indeed, and may well excite the sympathy of the philanthropic. Perhaps the government may aid in preserving these people by the enactment of laws for preserving game both on sea and land. This would help to some extent, but in the opinion of those competent to judge the only chance of preserving a remnant of these people is for a paternal government to isolate them from the whites and plant them upon some island where they can be controlled and guided. Others, however, declare that the extermination of the adult Alaska Eskimo is inevitable, and that the only thing to do is to save and educate the young.

* By Enos Brown, for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE LANGUAGE AND ORIGIN OF THE BASQUES.

THE Basques or Euskaldunak, i. e., "the Men," as they call themselves, are a most remarkable people who have long been an interesting problem to ethnologists. The most anomalous point about the Basques is their language, which is as typically agglutinative as any Asiatic or American tongue. Ripley, in his fine book "The Races of Europe," points out that the verb habitually includes all pronouns, adverbs and other allied parts of speech; as an example of the appalling complexity possible as a result, Bladé gives fifty forms in the third person singular of the present indicative of the regular verb "to give" alone. Another often quoted example of the effect of such agglutination occurs in a reputed Basque word meaning "the lower field of the high hill of Azpicuelta," which runs,

Azpilcuelargaraycosaroyarenberecolarrea.

No wonder that the French peasants state that the devil studied the Basque language for seven years and learned only two words. Like many other undeveloped languages, the principle of abstraction or generalization is but slightly developed; for example, as there is no general word for "sister," the Basques have to say "sister of the man" or "sister of the woman," etc. Owing to their isolation on both flanks of the Pyrenees, many primitive institutions persist among the Basques. In some places the eldest daughter takes precedence over all the sons in inheritance, which may be a relic of a former matriarchal family; communal ownership within the family is frequently practised. The re-

markable custom now known as the couvade, in which the father takes to his bed on the birth of a child, was attributed to these people by Strabo, and it is believed by some not to have completely died out at the present day, though there is great difficulty in proving its existence, as G. Buschan points out in Globus (Bd. lxxix., p. 117). H. Schuchardt has recently (Globus, Bd. lxxix., p. 208) expressed his wonder that this statement has again been dragged from the realm of fable. The same writer makes some remarks on misapprehensions respecting the Basque language.

Many wild theories have been promulgated as to the origin of the Basques, one of the most absurd being an attempt to relate them with a certain tribe in Central America. Several scholars have sought to affiliate the people with Lapps and Finns, and they have been supposed to be related to the ancient Egyptians, the ancient Phœnicians, the extinct Etruscans and to the Picts. The Basque language appears to be absolutely without connection with any of the so-called Turanian (Ural-Altaic) languages, since, as Keane shows in his "Man, Past and Present" (p. 460), there is no longer any doubt as to the relationship of the Basque with the Berber language.

The anthropometrical evidence has given rise to much controversy. The French Basques have an average cephalic index (on the living) of 83, while the Spanish Basques average 78, according to Collignon, and 79 according to De Aranzadi, in the graphic curve

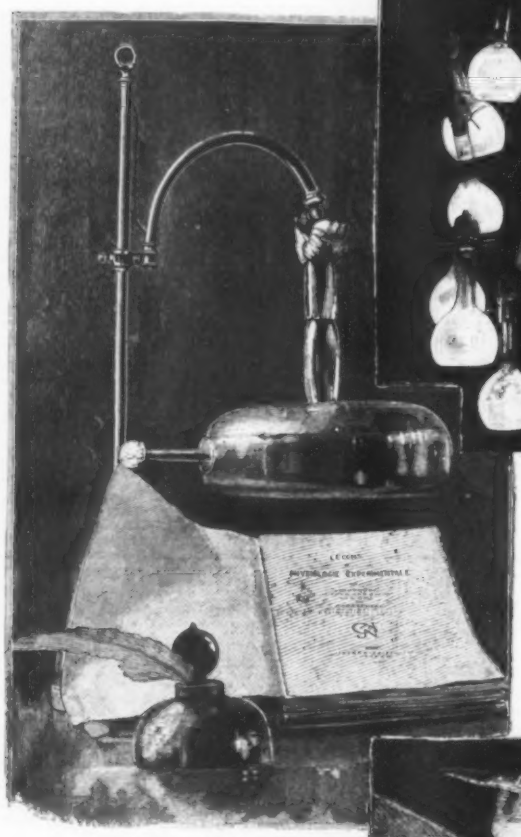


FIG. 1.—THE LIVING LAMP.

published by the latter anthropologist, who, by the bye, is himself a Basque; there are two distinct maxima, one at 76 and the other at 80, indicating, probably, that there are at least two elements in the group. The French Basques are on an average three-quarters of an inch shorter than their Spanish brethren, 1,657 mm. (5 feet 5¼ inches) and 1,638 mm. (5 feet 4½ inches) respectively. Both branches of the stock have a similar very characteristic head; the cranium is distinctly long even in the most brachycephalic subjects, and is enormously swollen in the temporal region, a character which is absolutely peculiar to this people, the forehead is high and straight and narrow below, the face is very elongated and has the shape of an inverted triangle, the chin being thin and pointed; the nose is correspondingly long and narrow. Certain anthropologists have claimed that those Basques who live north of the Pyrenees more nearly represent the primitive stock, while the same has been asserted for those south of that range. De Aranzadi thinks that those Spanish Basques with dark hair and eyes and a rather narrow head and of middle stature are of true Iberian origin, and are related to the Berbers. Those with darkish brown hair and greenish hazel eyes, a broad head and low stature are, according to him, of Ugrian or Finnish descent. G. Buschan, in a recent number of Globus (Bd. lxxix., p. 123), regards it as highly probable that the Basque race resulted from a crossing of the short-heads of the earliest prehistoric time, who probably wandered from Asia into Europe, with the long-headed indigenous Mediterranean race. The first of these two constituents he recognizes as the race of Grenelle (French authors) or as the type of Sion or Disentis (His-Rütimeyer) or as the Celts of Broca. Buschan has overlooked the fact that Canon Isaac Taylor, in his "Origin of the Aryans," had suggested this same explanation in 1890, and Beddoe had alluded to it in his "Anthropological History of Europe" in 1893. De Aranzadi recognizes a third element with light hair, blue eyes, narrow head and tall stature, which is a later addition of Kymric or Germanic origin, and he suggests that this element is related to the accursed race of the Cagots, who were isolated from their neighbors and had a separate church door for themselves.

Collignon, who has made many brilliant studies in the anthropology of France, draws attention to the very anomalous relation that exists between a cephalic index of 82.5, which is clearly brachycephalic, and a cranial length as great as 191 mm. He is of opinion that this permits us to look for the affinities of the Basque race more in the direction of the long-headed races; the Nordic, or Teutonic, being clearly out of the question, relationship must be sought among the Mediterranean group of peoples rather than in the direction of the brachycephals of France and of Central Europe. Collignon's view is that the Basque type is a variety of the Mediterranean race that has for a long period of time been geographically isolated, and the retention of a difficult and uncouth language has formed an equally efficient linguistic barrier. These factors induced in-and-in-breeding, and a well-marked human variety has resulted. Collignon's contention that the French Basques more nearly represent the primitive stock is now generally admitted; the head of the Spanish Basques has been narrowed and their stature diminished by mixture with Spaniards who had been driven into the mountains by the Moorish invasion. Those who desire to learn more about this paradoxical people will find numerous references to the literature in the valuable appendix to Ripley's "Races of Europe," and additional titles are given by Buschan in Globus (Bd. lxxix., February 28, 1901).—A. C. H., in Nature.

FIG. 2.—BUST OF CLAUDE BERNARD ILLUMINATED BY MICROBES.

FIG. 3.—BOOK PLACED BENEATH THE LIVING LAMP.

Coal in Germany.—The North German Lloyd, at Bremen, and the English Gas Company, at Berlin, have placed large contracts for coal in England, and as a result German mining shares have been somewhat affected. This step has caused surprise and regret in commercial circles here, as it is a well-known fact that German coal companies, particularly the Rhenish-Westphalian coal syndicate, have a large supply of coal on hand. This stock, it is said, amounts to several hundred thousand tons. As neither the North German Lloyd nor the English Gas Company would have purchased coal abroad could it have been procured in Germany at equally favorable terms, it is evident that German coal dealers have not reduced their rates to the level of their English competitors. Neither private mines nor those belonging to the State are willing to moderate prices, which are the same as when the scarcity of coal was most severely felt; this, too, in spite of the fact that all kinds of merchandise have been so low as to cause serious apprehension.

In view of these conditions, it appears to me that the present is an excellent chance for United States mine owners to gain a firm foothold in the German coal market. Quick and judicious action would result in profitable trade. German manufacturers will welcome the invasion with open arms.—O. J. D. Hughes, Consul at Coburg.

LIGHTING BY MICROBES.

WE present herewith some reproductions of photographs that were sent to La Nature from the maritime laboratory of biology of the University of Lyons at Tamaris-sur-Mer, where M. Raphael Dubois, its director, is pursuing his researches upon the light produced by living beings.

Fig. 2 represents the bust of Claude Bernard illuminated by means of small glass balloons.

The engraving well shows the impression that the eye experiences at the moment that it is looking at the illuminated object; but it takes several hours' exposure to obtain a photographic negative, and this proves that in this soft light there are a very small number of chemical radiations in proportion to the simply illuminating ones. The calorific radiations also are produced in infinitesimal number, so that almost all of the photo-biogenic energy is employed in making light, contrary to what takes place in all the different kinds of lamps known.

A photograph of Franklin was once taken with flashes of lightning, and now we have a portrait of Bernard taken with living light. M. Dubois took photographs of Claude Bernard and Paul Bert as long ago as 1886, but these were obtained through the light of those wonderful tropical insects called cucuyos (*Pyrophorus noctilucus*).

In Fig. 1 is shown the arrangement of the living lamp. The apparatus consists simply of a metallic standard supporting a large flat-bottomed glass receptacle provided with a tubulure at one side and another at the top. Both are loosely plugged with cotton so as to permit of a circulation of the air. The top of the receptacle is covered with tinfoil serving as a reflector. When it is desired to increase the light, there is adapted to the lateral tubulure a very simple arrangement that permits, through a rubber bulb, of occasionally injecting a small quantity of filtered air into the luminous bouillon, which at once gives forth its most brilliant effect. This lamp may be used for several weeks in succession without it being necessary to change its contents or to add any new nutritive liquid. Its life is so much the more prolonged in proportion as the liquid is less agitated by the passage of the current of air. At the beginning of the Exposition M. Dubois adopted a still simpler arrangement for lighting one of the halls of the Palace of Optics, and for this purpose made use of glass vessels of which the internal wall was simply coated with gelatine upon which photobacteria were strewed.

M. Dubois has more recently succeeded in considerably increasing the power of such illumination, some idea of which may be obtained by taking a glance at the book placed beneath the lamp in Fig. 3.

A LETTER FROM ROME.

By Madame SOPHIA BOMPIANI, in The Christian Work.

IT is not quite true, as some have said, that "Italy lives upon its past," for it has also an active and progressive present. Yet the preservation of the monuments of their ancient glory is a passion with the Italians, who consider that this increases the dignity of the nation, and that "a long history makes a great people." The very impatience they show when frescoes of Pompeiian houses fade or mosaic floors are neglected, when a precious vase, or picture, or statue, or some valuable collection of coins, or books, or manuscripts are taken secretly abroad or openly sold to foreigners, proves how highly they value the artistic treasures of the last three thousand years found in the soil of Italy.

This buried artistic patrimony is so abundant and so constantly increasing that often, through ignorance or neglect, some objects are lost or injured. The law recently presented to Parliament for the protection of these treasures keeps a just balance between the rights of the government and of the individual owners of pictures, statues or any other old artistic or historic object. The government reserves to itself the privilege of buying the property, which otherwise might be sold abroad, as so much of the art treasures of Italy has already been sold. Old churches, temples or ruins are declared national monuments, like the buried cities of Pompeii and Herculaneum and the Roman Forum, and are repaired or cared for.

Money does now what force did in 1798, when Bonaparte carried off to Paris the rarest pictures and statues in Rome, Florence and Venice. They returned from that exile after the fall of the conqueror; but some, like the "Wedding of Cana," by Paul Veronese, were forgotten, and now ornament a foreign gallery. By this new law no catalogues will be made, all objects being subject to the control of the government, and not alone those enumerated in ponderous inventories. The exact rights of owners with regard to the state have often been a subject of controversy. The finding of a precious sculptured sarcophagus or an ancient, frescoed room in the vineyard or the garden, which the owner could not sell but must take care of, was more frequently bad than good fortune.

There is now a question between the owner of Boscoreale, near Pompeii, and the government, with regard to some frescoes lately discovered there. The Deputy Signor De Prisco found in his property several years ago many exquisite silver ornaments and vases, which, thinking they were his own, he sold to a Rothschild, and they are now in the Louvre at Paris. Other objects went to London, and the Museum of Naples bought the remainder, which are inferior in artistic value, for $3,000. Yet these are most beautiful. There is a silver statue of Isis, with the lotus flame upon her head, a rudder in her right hand, and a bunch of wheat in the left. It is, including the pedestal, only nineteen centimeters high. There is also a small statue of the Venus Aphrodite, a serpent ready to strike, and a wild bull. These things are supposed to have been in the Lararium of the rich private citizen, Gneo Domito Aucti, whose name is found there. But these articles of silver were far less valuable than the seventy frescoes found lately on

the walls of three or four rooms which De Prisco has excavated. All of these pictures, representing the festivals of Isis and Ceres, a Victory, an Amazon and many other mythological subjects, for their elegance of form and expression, their brilliant coloring and large size, are superior to any yet found in Pompeii. The owner and excavator intended to remove and sell these frescoes at the highest price he could get; but when the government intervened he agreed to give it the preference at one-third less than he could get elsewhere, the money to be paid in ten years, without interest. He agreed also to make the excavations under the direction of a government inspector, and with the constant presence of two guards of Pompeii. Yet, as if this were not enough, the government claims the entire ownership of the frescoes which were dug out by De Prisco thirty feet below the level of the ground. He naturally rebels, and I believe the question is not settled yet. Another similar case is the discovery of an ancient Roman villa near Herculaneum, with frescoed walls and mosaic floors, which the owner notified at once to the government, and only after long delay received an order to stop all further excavations.

Prince Chigi, of Rome, was more fortunate in the suit brought against him for selling a picture in his gallery, "The Virgin and Child," by Botticelli, which, according to some old edicts of 1801 and 1820, should not have left Italy. He was at first condemned to pay to the government the entire sum received, $63,000. But after long debate in the court about the present validity of the Pacca and Doria edicts and the right of a citizen to dispose of his own, the fine was reduced to $400, and afterward, by the amnesty, to $40.

A precious fresco lately discovered in the Church of Saint Cecilia in Trastevere has been taken possession of by the government, and will be zealously guarded. It is in the choir room of the nuns, and the benches will be either drawn out from the wall or entirely removed. The painter is supposed to be Pietro Cavallini, doubtless the best of the Roman middle age artists.

The ruins of ancient Tusculum, on the hill behind Frascati, have recently been declared a national monument. They will now be carefully guarded. The lowing cows will no longer rest in the villas of Tiberius and Cicero; the shepherd boy will not eat his bread and *ricotta* on the steps of the theater, and the wandering stranger will not go as freely over the old stone roads as before. The wildness and loneliness of the dead city, once so gay, were its charm, that now perhaps will vanish. Yet the view, from the highest point, of the wide panorama, limited only at the horizon by the shining sea, cannot be spoiled even by guards and fines.

But while so zealously watching a stray picture or statue, the excavation which a proprietor makes on his own grounds, or the frescoed walls of old churches, covered with whitewash, the government of Italy neglects the Catacombs, leaving them in the care of the priests. The history of the Catacombs is that of the first centuries of Christianity in Rome, and the wealth of knowledge they contain is proved by the colossal work of the archæologist De Rossi. These Christian cemeteries, forty-two in number, only twelve of which have been explored, should be in the hands of the government and declared a national monument.

The committee selected by the Vatican, and presided over by a cardinal, has no legal existence, and only continues by the neglect of the Italian government, and partly out of deference to De Rossi while he lives. The Pope, by the Law of Guaranties, has no power over cemeteries outside of the walls, and these Catacombs cannot be considered as churches which they never were. In all the laws of the unification of the artistic patrimony, made but not executed since 1870, once only has mention been made of the Catacombs. In the meanwhile, inestimable treasures in pagan and Christian inscriptions and sculptured sarcophagi are carried away against the Pacca law and stored in the Lateran Museum, which belongs to the Vatican. The friars of the Catacombs of San Calisto take in about $5,000 annually for entrance fees, and this is an enormous proportion of the $60,000 received from all the other museums, galleries and monuments of the kingdom. The necessity for the State to take possession of the Catacombs is obvious when it is considered that there are immense subterranean galleries perforating in every direction the whole campagna around Rome, and even passing under some of the seven forts. The danger of leaving these underground passages in the care of private individuals, if there should be a war or revolution, is evident.

The King of Italy, by the purchase of the valuable numismatic collection of the late Marquis Marignoli, consisting of 32,000 coins bought without regard to cost during fifty years, has rendered a real service to his country. He has saved it from inevitable dispersion or emigration, and completed his own collection, which is now the most important in the world. Exclusive of duplicates, the King's collection consists of 50,000 coins, arranged in twenty-four large cases in the apartment above his own, in the little palace of the Quirinal. There he studies these coins, which are in fact the history of Italy, several hours every morning from six to nine, when the cares of State permit. They consist chiefly of the products of the mints of Italy.

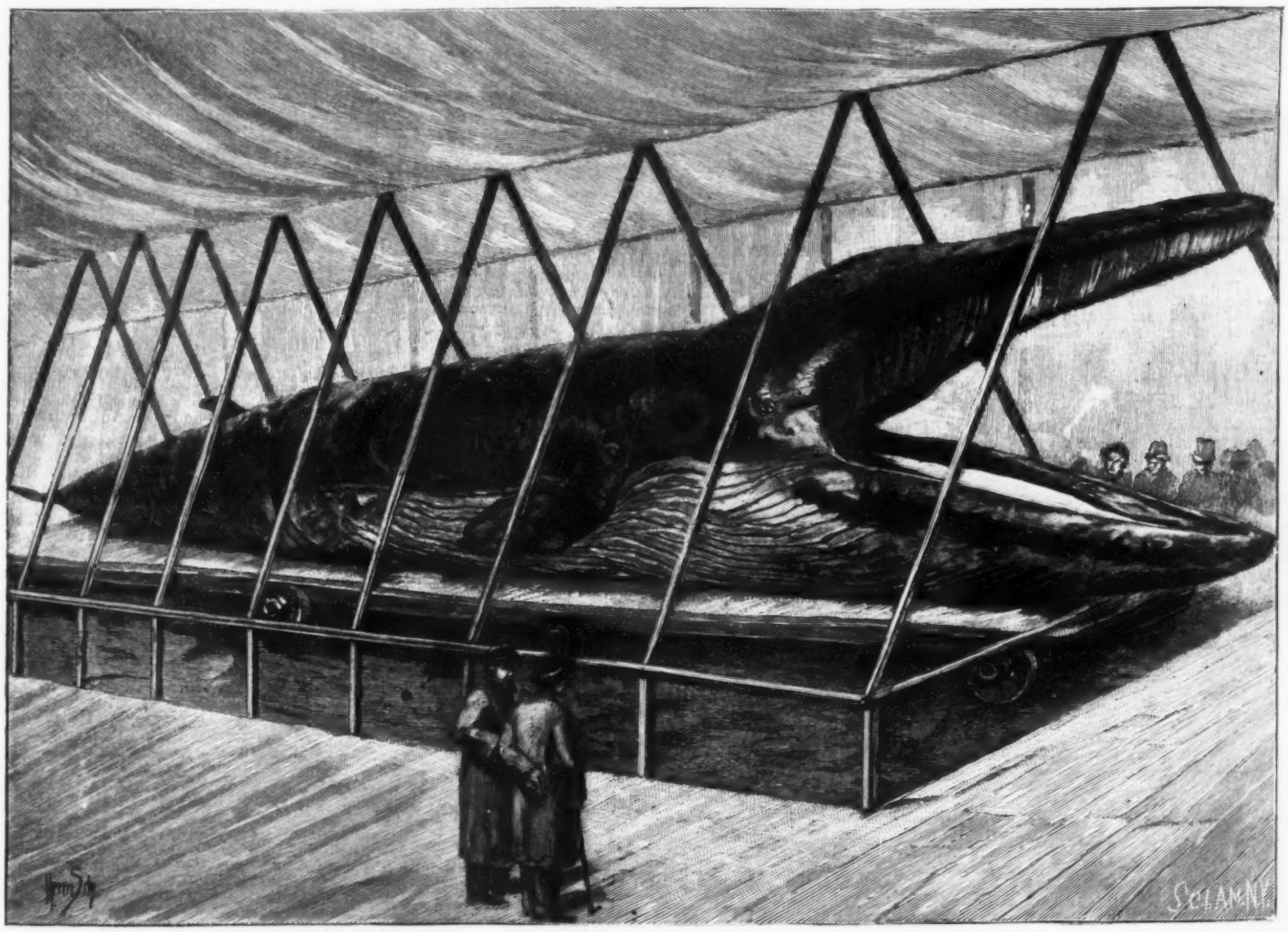
He has the series of the Popes before the year 1000 A. D., and also those issued at Avignon; one hundred gold coins of the Roman Senate and all those of the Camerlingi during the Papal vacancies. He is now engaged in preparing a work of sixteen quarto volumes, to be called the *Corpus Nummorum Italicorum*, which will cost about $40,000.

To the King is partly due also the solution of the problem of the Villa Borghese, a large and beautiful garden—a very bit of the country—at the gate of the city, which was in danger of being cut up and sold for building lots. As a memorial to King Humbert, whose name it will take, the Villa Borghese has been bought by the government and presented to the city of Rome, on condition that it be kept as a public garden and joined by a bridge to the Pincio. On the front of the Pincio, facing the Vatican, and overlooking the Piazza del Popolo, the King will erect an equestrian statue of his father, King Humbert. Thus is secured to the population of Rome a garden, perhaps the loveliest of which any city can boast, and at the same time a fitting memorial to the King whose life was dedicated to his people.

Not so much can be said for the utility of the monument in memory of Victor Emmanuel II. It occupies the side of the historic Capitoline, and in digging the foundations of the monument, in reality an immense marble palace that will cost five million dollars, many ancient walls, hidden rooms, subterranean galleries, wells and drains were found. It faces the Corso—now Corso Umberto I.—or will face it when many houses and palaces are demolished. It will have many statues and columns, and will be used as a museum for the souvenirs of Italian independence.

THE BERLIN MUSEUM'S RIGHT WHALE.

ACCORDING to the Illustrirte Zeitung, the Berlin Museum of Natural History numbers among its collections a magnificent stuffed specimen of right whale about 55 feet in length. The general color of the hair is blackish above and grayish-white below. The pectorals are 8 feet long and 4 feet wide. The mouth is 13 feet long and 5 feet wide. The eyes are no larger than those of a cow and have a white iris and are placed about a foot obliquely above and behind the angle of the mouth.



A LARGE RIGHT WHALE.

The whole structure of a whale is a most instructive instance of a type of organization which is characteristic of all mammals, but is in this instance especially modified to a peculiar mode of life. The external fish-like form is perfectly suited for swimming through water; the tail, however, is not placed vertically as in fishes, but horizontally in a position which accords better with the constant necessity of rising to the surface for the purpose of breathing. Unlike most mammals, the whale is almost devoid of hair. Only a few short bristles appear about the chin or upper lip. The body is kept warm by a thick layer of "blubber," or dense fat, located immediately beneath the skin. The four limbs, though functionally reduced to mere paddles, with no power of motion except at the shoulder and joints, have beneath them smooth, continuous external muscles covering all the bones, joints and even most of the nerves and arteries like the human arm and hand. Rudiments even of hind legs are found buried deep within the animal, apparently serving no useful purpose, but pointing an instructive lesson to those who are able to read it.

The whale illustrated was captured along the eastern coast of Greenland at about 64 degrees north latitude.

German Demand for Linoleum.—Consul Hughes reports from Coburg, April 29, 1901, that Messrs. Gebrueder Weisbach, of Strassburg, Alsace, would like to know the names of American manufacturers of linoleum, 4 yards wide. Communications should be addressed to them.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Packing Goods for Foreign Markets.—The following is extracted from the annual report of Consul Fleming, of Edinburgh, which will appear in full in Commercial Relations, 1900. The suggestions herein contained are thought of sufficient importance to warrant publication in this form. Mr. Fleming says:

The importance of the proper packing of goods for export is a matter concerning which there is no room for two opinions. If it were not common knowledge that the arrival of merchandise at its destination in good condition is as essential to foreign business as it is to home trade, the fact that space in the Paris Exposition was devoted to object lessons on packing would show that the commercial world recognizes it as a vital part of the process of getting and holding any market. The manufacturer or exporter who wins a reputation for the best packing of articles has a distinct advantage in the foreign trade, prices and quality of goods being satisfactory.

I have undertaken to gather information and collate opinions of manufacturers, importers, and exporters, and well-informed shippers, casemakers, and stevedores in this district, on the subject of packing goods. This information and these opinions relate to imports and exports to nearly all countries, covering many kinds of merchandise. This work has been done with the idea that possibly American manufacturers and shippers will derive, from the facts and views stated, some benefit in the way of suggestion. At the risk of giving much that may be superfluous, I have gone into details. No comparison is attempted of the methods of packing in different countries, the purpose being to describe or indicate the best method, irrespective of the country in which it is practised. But there are some exceptions to this rule, wherein American packing is directly commented upon.

With reference to the packing done by United States manufacturers and other producers and the export houses, little fault is found with it, especially of machinery, hardware and wood ware, bottled and canned fruit, and catsups, sauces, and the like. There is a discordant note as to one kind of raw fruit—apples—the objection being, however, not to the packing of the fruit, but to undersized barrels.

There is also criticism of cheese boxes. One provision dealer writes that he has "always considered the wood protection insufficient, and especially the fastening of the lids, which might be improved, as a great many come here with the lids off, and in this case the cheese is likely to get damaged, in addition to the damage to the box itself." Some fault is found, also, with the American packing of clocks, bicycles, and bicycle parts, wood pulp, hams, cotton-seed meal, rosin, tobacco, and a few other articles. In most cases, the complaints relate to defects which could easily be remedied.

In these paragraphs, the words following the figure (1) denote the more important forms in which an article is shipped, the most common form being stated first; the matter following the figure (2) describes or indicates the method of packing considered by shippers and importers to be the best, or gives the opinion commonly held here regarding the way packing is now done. Where there is practically only one form of package or only one way in which an article is prepared for shipment, the figures are omitted, and the matter relates to the best method of packing or some feature of it, or comments on present methods. I should add that, although the export case universally recognized as the best for all goods requiring special protection from moisture is a tin-lined or zinc-lined case, where the word case is used in these pages, the ordinary wooden case is meant, unless otherwise stated.

Acids.—(1) Barrels, baskets, kegs, carboys. (2) For dry acids the barrels should always be paper lined to prevent leakage.

Ale.—(1) Barrels, cases, kegs. (2) Usually 96 half bottles, stone, wrapped in loose straw, are put in a barrel and packed thus: Bottom tier of barrel, 24 bottles, standing, with heads upward; second tier, 25 bottles, necks downward; third tier, 27 bottles, with heads upward; top tier, 20 bottles, necks downward. When packed in cases, about 10 dozen pints to a case, the stone bottles are inclosed in straw envelopes. Strong barrels and cases are required.

Alum.—(1) Bulk, bags. (2) Cake alum, now generally shipped in bulk, should be packed in bags to save shortages. It is thought that the change would prove economical in the long run.

Ammonia.—(1) Cylinders, packages. (2) Cylinders should be strongly cased over for protection.

Aniline dye.—(1) Barrels, packages. (2) All casks or barrels should be paper lined.

Apples.—(1) Barrels, cases, bags, baskets. (2) American apples are generally well packed in the ordinary way, the barrels remaining in fair condition as long as any other, but it is said that the fruit keeps in a better state when shipped in barrels ventilated by small diamond-shaped holes cut in four places in the staves. This is a Dutch idea, and the apples from Holland arrive in a more marketable condition, as a rule, than those from any other country, although the quality is perhaps inferior.

Bagging.—(1) Bales, bundles, packages. (2) Bags are in press-packed bales, covered with strong jute cloth and bound with steel hoops.

Beer.—(1) Barrels, kegs, cases. (2) It is considered essential that beer barrels be as free as possible of tannin and always iron bound.

Bicycles.—As a rule, the material of which American crates are made lacks the proper strength. The same is true of the cases in which bicycle parts are shipped. Solid crates and cases are required, as rough handling is always to be expected.

Biscuits.—Tins, packed in close-fitting cases, any spare space being filled in with straw.

Bleach.—Barrels lined with stout paper.

Bolts and nuts.—(1) Boxes, bags, packages. (2) Extra-strong cases and tight packing necessary, owing to the weight. Bolts shipped in bags are sometimes damaged by water and dampness and otherwise.

Bone meal.—(1) Bags, cases, packages. (2) Bags well made of strong material.

Books.—Owing to the weight of books, large boxes or cases are unwieldy. It is best to pack books back and front edges alternately, with paper between every row and every layer. Leather-bound books and other valuable works are wrapped up separately in paper. The box should be lined with waterproof paper. It is necessary to hoop each box and secure with screws.

Boots and shoes.—The common style of case firmly packed and secured around the ends fully serves its purpose everywhere.

Bottles.—(1) Mats, crates, bales, bags, cases, barrels. (2) In shipments of the ordinary whisky and wine bottles, there is generally a considerable loss by breakage. The most satisfactory method of shipping is in mats well packed with straw.

Brandy.—(1) Cases, barrels, hogsheads, octaves, tuns, vats. (2) Great care must be taken to properly secure cases at the lid and barrels at the bunghole.

Brooms.—(1) Bales, bundles, cases. (2) The importance of stoutly binding bales and bundles must not be overlooked; otherwise, the best handling will not save them from damage.

Burlaps.—Bales covered with jute cloth and steel hooped.

Butter.—(1) Boxes, tubs, barrels, cases. (2) Danish butter, the standard article here, is shipped in white-pine cubical boxes, each box containing 56 pounds, thin paper separating the butter from the wood.

Caoutchouc.—(1) Bags, bales, cases, barrels. (2) The bags must be made so secure that they will stand the roughest usage.

Caramel.—(1) Barrels, kegs. (2) Paper lining is necessary to prevent leakage.

Cement.—(1) Bags, barrels, crates, bulk. (2) Bags of strong quality are required, and in this form the cement is best adapted to commercial uses.

Chairs.—The binding of cases and crates too often prove insufficient. Care should be taken to make the protection adequate and strong.

Cheese.—(1) Boxes, cases, barrels, tubs. (2) Boxes of good material should be used in the cheese trade, and the lids so well fastened that they will not come off in handling at the wharves. Some Canadian shippers of cheese are more careful in this respect than the American shippers.

Chemicals.—(1) Bags, barrels, bales, cases, drums, packages. (2) For chemicals in a dry state, casks and cases (when the latter are not tin or zinc lined) should always be lined with thick or very tough paper.

China ware.—(1) Barrels, hogsheads, tierces, cases. (2) Special care must be taken to pack the barrels closely with straw. The ware is wrapped in tissue paper and delicate ware or vases in corrugated packing paper.

Clocks.—In many American cases, the wood protection is too slight. Good and strong material should be used.

Coffee.—It is questionable whether the average bags in which coffee and coffee husks are shipped are strong enough. There is much loss at most ports in handling.

Colors.—(1) Barrels, bags, bales, cases, packages. (2) Barrels properly lined with paper.

Copper ware.—Extra-strong cases are required and they should be of moderate size.

Cordage.—(1) Bales, bundles, cases. (2) Bales bound with the same material and hooped with iron.

Cork.—(1) Bales, bags, bundles. (2) Bales wrapped in coarse bagging and hooped.

Cotton.—The improved packing of cotton in the common way, by the square-bale compress companies, has attracted attention on this side. Cotton dealers are very favorably impressed with the round bales, which bring the cotton in excellent condition, as a rule.

Cotton goods.—Manufactures of cotton and linen yarns are packed in the same way as linen. (See Linen.)

Curtains (lace).—Each pair wrapped in white casing and yellow lining and then packed in a bale covered with waterproof paper and canvas. Large shipments are made in wooden cases lined with waterproof paper.

Cutlery.—Wrapped in thin paper, packed in cardboard boxes, and then in a tin-lined case.

Earthenware.—(1) Crates, cases, barrels. (2) Packed in straw in wooden crates. Where liquid gold is used in decorating, the ware is wrapped in tissue paper.

Eggs.—It is thought that the cases now used in commerce lack strength, and that a little improvement in this respect would bring profitable results to shippers everywhere.

Envelopes (straw).—(1) Bales, bundles, bags. (2) The proper bales are well bound with wire.

Esparto.—The bales are strongly bound with ropes made of the same material.

Farina.—(1) Bags, barrels. (2) The ordinary bags used are hardly as substantial as they should be. There is loss from leakage. A bag of slightly better material would be a perfect protection.

Fish.—(1) Barrels, bags, bundles, cases, kegs, bales. (2) Nearly all dried fish are properly shipped in bundles made of bagging and mats sewn together. Salted dried fish are best in tin-lined cases. Herrings are generally packed back downward in barrels bound with wood, iron hooped. Fault is found with the fish barrels commonly used here. It is held that they should be bound with iron, not wood.

Fishing rods.—Tightly bound at the ends and in the middle with cord and packed in a strong wooden box the length of the rods.

Flax.—(1) Bales, packs, bobbins. (2) The bale is covered with a heavy mat made from the inside of a tree bark cut in strips about half an inch wide and woven together; sometimes press packed, if necessary, to economize space. Exported from Scotland, the bale is commonly bound with ropes of flax, which perhaps secure it sufficiently.

Flour.—(1) Sacks, barrels. (2) The jute sack is a much better protection than the cotton, as it is stronger. Only winter-wheat flour comes in cotton bags. Bakers on this side prefer to have cotton bags for this class of flour, which always comes in half sacks. But flour dealers say that the cotton bags do not stand the wear and tear in transit so well as jute. The quality of the cotton, however, has been much improved in the last two or three years, importers insisting on getting heavier and stronger sacks, as, when they burst, the millers have had to pay the loss when the inspectors certified that the textures of the cotton was not sufficiently strong; so that for their own protection they are now putting flour into more substantial bags.

Furniture.—Finished furniture of value, such as desks and bookcases, reaches its destination in the best condition when covered with paper and then with matting, or some other soft material, before being crated or cased.

Fruit (small).—(1) Boxes, cases, bags, baskets, bales, sieves, barrels, crates, chips. (2) The boxes, cases, and baskets in which most of the different varieties of fruits are now received here from the Continent and America are quite sufficient for their purposes, but it is suggested that raisins should be packed in heavier boxes than at present, as there is much waste through weak boxes.

Gelatin.—(1) Cases, bags. (2) The finer quality of gelatin is inclosed in cardboard boxes, which are wrapped in paper in suitable parcels, and these parcels are then packed closely in a wooden case.

Glassware.—(1) Cases, barrels, crates, tierces. (2) In cases or barrels, properly stowed in hay or straw, perfectly separating each article.

Glass plates.—From 12 to 60 plates are put in a case, tissue paper being laid between the plates to prevent scratching. The inside bottom of the case is first covered with a layer of wood shavings, then come the plates, then on top a layer of wood shavings. The box is somewhat larger than the plates, so as to allow shavings to be stuffed all around. From 8 to 10 of these boxes are then packed in a large surcase, tightly stuffed in with straw, and this surcase is hooped with iron.

Glucose.—(1) Barrels, bags. (2) Barrels should be properly hooped to prevent expansion and leakage.

Golf goods.—Clubs are put in a large box, with sheets of paper between each layer of clubs to protect the varnish on the heads. Balls in 1-dozen boxes, each ball wrapped in paper, are best packed in a box about 1½ inches thick, which should be hooped with iron.

Granite.—As a rule, the unpolished blocks carry well naked, though it is better to stow them in straw on the ship. When polished, the blocks must be packed in extra-strong crates or cases.

Grindstones.—(1) Barrels, cases. (2) Put in strong barrels of a size suited to the diameter of the stones and tightly packed with shavings or straw.

Grits.—Bags should be of first-class quality.

Guano.—Only good, stout bags are satisfactory.

Hair.—(1) Bales, bags. (2) Bales are wrapped with bagging.

Hams.—(1) Barrels, cases, bags. (2) There is more or less complaint that cases of American hams are not substantially bound. They should be rendered secure enough to withstand very careless usage.

Handles.—(1) Cases, crates, bags, bundles. (2) Handles in any sound case are always secure enough, as are short handles in bags. To put in bundles is poor packing, unless the ends are very firmly bound. Those from America are cased and come in first-rate condition.

Hardware.—(1) Cases, barrels, crates, packages. (2) Cases from the United States are notably strong. The best material is used in making them.

Hay.—Bales should be bound with strong wire.

Hides.—(1) Bundles, bales. (2) Mostly imported here in a raw condition in bundles of 1 each, properly bound with stout twine.

Hoops.—(1) Bundles, bales, coils. (2) Largely put up in bundles of moderate weight, which are bound with their own material.

Hosiery.—(1) Cases, packages, bags. (2) The finer grades of hosiery, as well as gloves and mitts, are put in cardboard boxes and then cased. The coarser grades of knit goods are sometimes shipped in the form of paper parcels, but it is best to first wrap the goods in light oilcloth.

Implements.—Well-made cases suited to the goods, such as are now used by American exporters in this line. It is the common testimony that all implements from the United States arrive in better condition, as a rule, than those shipped by English and continental makers.

India rubber.—(1) Bags, cases, barrels. (2) When not in cases, it is best packed in bags made of canvas.

Ink (printing).—(1) Cases, barrels. (2) The ink is put in tins of various sizes, then these tins are carefully packed in cases to contain not more than 200 pounds, for easy handling. The tins, before being packed in the case, are properly wrapped with paper. Sometimes the tins are hermetically sealed, and when packed in removable lids, the lids are gummed on with waterproof sheeting.

(To be continued.)

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No. 1052. June 3.—Cement in Canada, Latin America, and the West Indies.

No. 1053. June 4.—British Cotton-Goods Trade in Latin America.—Coal Mining in Dutch India.—New Railroad Bridge in Russia.—New Smelter in British Columbia.—*Demand for Palms in Hungary.—Density of Population of Foreign Countries.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

To Keep Flowers for Photographic Purposes Fresh for a Long Time.—Those interested in photographing flowers may be pleased to know the following process published in Helios, whereby flowers can be kept fresh for some time. It consists in sprinkling the flowers constantly with water and to keep the stems in the following mixture, which has to be renewed daily: Water 1,000 c.cm., white soap 30 grammes, cooking salt 3 grammes. When the soap has fully emulsified, a little powdered borax is added.

Practical Experience in the Preparation of Plaster of Paris.—Ordinary plaster of Paris is brittle, porous and hygroscopic, and by absorption of water becomes a conductor of the electric current, hence is unsuitable for electro-technical purposes. In a hardened condition, however, it is serviceable for parts which are neither under high tension nor exposed to high temperatures and great changes of temperature. In the latter cases the expensive putty of litharge and glycerin must be used.

The hardening of the plaster of Paris is accomplished in the following manner:

1. Intimately mix with the powdered gypsum 2 to 4 per cent of powdered marshmallow root and knead into a dough with 40 per cent of water. The mass resembles fat clay, hardens after about one hour and is then so tough that it may be cut, filed, turned and drilled. An admixture of 8 per cent of marshmallow root renders it still tougher. Instead of the marshmallow root, dextrin, gum arabic and glue may also be employed.

2. If 6 parts of gypsum are mixed with 1 part freshly slaked lime and the articles in question shaped from this and saturated with concentrated magnesium sulphate solution, the plaster becomes so hard that it cannot be scratched with the finger nail.

3. Digest gypsum after the burning with 10 per cent alum solution and burn once more after the drying. On being stirred with water the gypsum solidifies into a marble-like mass, the so-called marble cement.

It is essential that the gypsum be always added to the water in small quantities, not vice versa, and that it be stirred quickly, otherwise lumps will form. The water-absorbing property is removed by saturating with a solution of ozokerite or wax in oil of turpentine, varnish, etc.—Pharmaceutische Centralhalle.

Cement for Wood and Tin.—In order to intimately unite wood and tin by the use of a cement, melt in a thick-walled iron vessel 1 part of yellow wax, stir in 2 parts of gutta-percha chips to complete dissolution and dissolve therein 2 parts of shellac and 0.1 part of boiled linseed oil. After the mass has cooled off, it is poured upon a somewhat moistened metal or stone plate; next it is kneeded and shaped into bars. The wooden or tin parts to be cemented are dried well and the melted cement is evenly applied on the wood and tin; the articles thus united are left alone for 24 hours, moderately pressed together. Very advantageous is a matting of the tin by scouring with emery. The process should not be conducted in too cool a place.—Neueste Erfindungen und Erfahrungen.

Advantageous Polishing Method.—It is a mistake not to first sandpaper wooden objects and finish rubbing down with water and pumice stone in almost every case. For this the wood need not be wetted immoderately. Always rub down before the staining, and the advantage by the wet rubbing down is that the wood will not warp any more. It is self-understood that dry wood has to be used for all work and that the wood must not be polished immediately after the wet rubbing down, as soon as it appears only half dry; it must, on the contrary, be allowed to dry at least 24 hours, because with an insufficiently dry foundation the polish will later on acquire all sorts of undesirable spots. When the wood has been rubbed down wet and stained and dried again, the pores are closed with thin polish and fine pumice-stone dust. Oil can be entirely dispensed with and should be avoided, although one may use a little petroleum in place of the oil. When the pores have thus been filled up, polish as usual, only with the difference not to use any oil, but petroleum in lieu of it. This furnishes a faultless, hard-polished surface which does not become rough and never exudes oil, and hence cannot turn unsightly, because no oil is present. Whoever has got used to this method of polishing will never return to the old one. —Praktischer Wegweiser.

Practical Directions for Imitating Rosewood.—For the imitation of rosewood the yellowish maple-wood is excellently adapted, or still more so the yellow boxwood. The piece of furniture in question is finished and all parts carefully rubbed down, whereupon they are coated with a solution of gelatin 1 part in water 4 to 6 parts. This coating is allowed to dry, whereupon the article is once more rubbed down with fine glass-paper and then with powdered pumice stone and water, using a piece of felt. Allow to dry well and prepare the following tinctures:

1. Aniline red, so-called coralline, 1 part, dissolved in 20 parts of spirit of wine.

2. Coralline solution 1 part, diluted with 10 parts of spirit of wine.

3. Aniline red, so-called roseine, 1 part, dissolved in 10 to 12 parts of spirit of wine.

Add enough aniline brown until a brownish-red liquid results. Now draw by means of a flat bristle brush parallel veins with coralline solution No. 2, about the breadth of a finger apart, placing others applied with solution No. 1 alongside, in such a manner that the translucent natural color of the maple-wood remains untouched; now blend by means of a few light strokes of a badger brush the pale and dark red lines, so that they softly fade into each other, whereupon the reddish brown veins are drawn by the use of the solution of mixture No. 3, placing them as closely as possible over the dark red veins. These are also blended by means of a badger brush, so as to cause the sharp edges to be softened as far as possible, whereupon allow to dry in a moderately warm place.

It is essential that the veins of pale red, dark and brownish red must always be applied in such interstices that the natural color of the maple-wood remains predominating. The polishing of the imitation rosewood is done by first putting on a coating of spirit varnish of the shade of yellow wine—so-called amber varnish—by means of a badger brush, as smoothly as possible, allowing to dry well. Next rub down with powdered pumice stone and water, then wipe the moist places dry with a soft piece of linen and polish off with copal polish, whereby a fine luster is obtained. If the natural shade of the maple is to appear pale, use a polish to which a little aniline yellow has been added. This admixture imparts to the polish of the stained wood surface a glaze color which gives more luster especially to the red veins.—Wiener Moebelhalle.

USE OF MAXIMUM SALTS AS REDUCERS OF THE SILVER PHOTOGRAPHIC IMAGE.

WHEN a negative is to be reduced, there are cases in which the reducing liquid ought to produce the desired result by acting in a way opposite to that of ammonium sulphate; that is to say, by increasing the contrasts.

This is the usual action of the reducers, in which the plates or papers are immersed.

This procedure, which is especially employed for negatives that have been over-exposed and too much developed, so as to reduce an image too intense in all its parts, has been usually two-fold:

1. By means of two separate solutions, one serving to convert the silver of the image into a compound soluble in sodium hyposulphite, and the other consisting of the fixing agent. But it is impossible to mix these two solutions, because a precipitate will be formed.

Cupric chloride and sodium hyposulphite, for example, realize these conditions.

2. By employing a substance which can be mixed with sodium hyposulphite without forming a precipitate and thus reducing the negative into a single solution.

This is the case with the Farmer liquid, composed, as is known, of a mixture of potassium ferricyanide and sodium hyposulphite, and now in current use.

The process based on the employment of two separate baths is not very practical, because the operation is somewhat left to chance. In reality, the progress of the reduction cannot be followed, and only after the passage through the second bath is it possible to judge of the effect produced.

Although the use of the Farmer liquid is an improvement on the process with copper chloride and sodium hyposulphite, it has marked inconveniences.

In the first place, the mixture does not keep; and at the end of a short time is spoiled, the ferricyanide being reduced by the sodium hyposulphite. Besides, if the mixture is not constantly agitated during the operation, there are irregularities in the action.

This difficulty prevents readily following the progress of reduction. Every time that the plate is examined by transparency, it must first be washed lest irremovable marks appear.

We have endeavored to replace the reducer composed of two separate baths, with a single solution capable both of forming the silver compound and of dissolving it.

With this aim we have experimented with different salts at maximum easily transformed into salts at minimum, whose acids might produce silver salts more or less soluble.

Use of Ferric Salts.—The ferric salts, especially the nitrate and sulphate, owing to this condition and perfectly dissolve the silver in neutral solution, according to the equation:

$$(SO_4)_3Fe_2 + Ag = SO_4Ag + 2FeSO_4$$

But they cannot be practically utilized because the negatives reduced by the aid of these salts have in the film a precipitate of ferric oxide or of basic salt, insoluble, when they are washed to eliminate the excess of the reagent, and the gelatine, although transparent, remains of a light yellow color.

We are aware that this difficulty may be overcome by passing the plate after reduction into a weak acid bath; an organic acid, for example; or, indeed, by adding citric acid, or even ammonium citrate or lactate, to the ferric solution; but not only is this a complicated process, but a more serious difficulty is that, during the reduction, the silver changes color and assumes a yellowish hue very different from the original.

We have tested, comparatively, with ferric peroxyd salts, an entire series of other salts at minimum, so as to generalize the method used on the direct reduction of a maximum salt by dissolving the silver of the image in the acid of the salt.

Use of Manganic Salts.—We have only tried as reducers those manganese peroxyd salts that are capable of being diluted with water without decomposition and keeping without undergoing marked change. Only a portion of the salts from organic acids possess this property.

These compounds have been obtained by the action of aqueous solutions of different organic acids on potassium permanganate in concentrated solution in water. The permanganate is precipitated from hydrated manganese peroxyd, which is redissolved cold in an excess of acid solution.

The brown liquid thus obtained with the manganic citrate, tartrate and lactate, might reduce the image; but not only are the solutions unstable and easily decomposed, but they also color the gelatine films yellow just as the ferric salts modify the color of the silver.

The manganic salts have, therefore, no practical interest as reducers.

Use of Peroxyd Titanium Salts.—When titanic acid TiO_2 is treated with oxygenated water, titanic peroxyd TiO_3 is obtained, which dissolves in various acids and yields red solutions, which are the corresponding salts of titanic peroxyd.

These salts, whose acids produce soluble compounds of silver, reduce the image more or less. Among these the titanic sulphate alone is a sufficiently energetic reducer.

The reducing power of titanic sulphate is manifested in a very striking manner. The gelatine film containing the silver of the image is detached in proportion to the action of the bath, in fine layers, without the underlying gelatine being changed, so that it is not only by simple dissolving of the silver that the reduction seems to be produced, but also by a diminution of the thickness of the gelatine film. This action, too, is more intense in the more transparent parts, causing a relief at the same time that the details are gradually dissolved away.

Use of Mercuric Salts.—Among these salts the nitrate alone can furnish practical results in the reduction of silver images.

The mercuric nitrate is liquid at the ordinary temperature. It must be used in a diluted solution, so that it may not exert a disorganizing action on the gelatine. Ten cubic centimeters are diluted in 200 c. c. of water. This solution, which can be increased by an excess of water without causing a precipitate of basic salt, reduces very rapidly the silver images, but the color of the silver, which does not seem sensibly modified when the plate is withdrawn from the bath yellows very markedly when it has been washed. For this reason the mercuric nitrate cannot be utilized practically.

The other mercuric salts produce in reduction some insoluble salts which, like mercuric chloride, render the film opaque and white.

Besides the mercuric salts, we have tested an entire series of other metallic salts, in which the peroxyd of the metal acts the part sometimes of an acid, sometimes of a base.

The *chromic salts*, the *chromates*, the *arseniates*, vanadates, tungstates and others, have given us negative results.

The maximum salts which have proved the best reducers are those of cerium peroxide; and among the different ceric salts, the sulphate has seemed to us to offer the greatest advantages.

Use of Ceric Salts.—The ceric salts whose acid yields a soluble silver salt, such as the sulphate and nitrate, reduce silver images very rapidly without producing any of the inconveniences of ferric salts. The sulphate, which is a commercial salt, is of the most benefit, the nitrate being rather rapidly reduced in a simple aqueous solution. The neutral ceric sulphate, it is true, precipitates in presence of water in excess. That difficulty, however, is easily avoided by adding to the solution a small quantity of sulphuric acid, which produces with the ceric sulphate an acid salt, exerting no disorganizing influence, even in concentrated solutions, on the gelatine.

The ceric sulphate can be used without difficulty in concentrated solutions; the rapidity of its action is proportional to the degree of the concentration of the solutions.

The ease with which it is dissolved in water, the great stability of the solution acidulated by sulphuric acid, the rapidity with which it can dissolve the silver, when in concentrated solutions, its very regular action at all degrees of concentration, and the possibility of utilizing the solutions up to exhaustion, and of preserving the solutions indefinitely, render this new reducer of very great benefit.

It has, further, the advantage of being able to reduce the prints on gelatino-silver bromide paper without discoloring the whites.

Reduction with Sulphate of Cerium Peroxide.—The concentrated solution of ceric sulphate which succeeds the best (to be afterward diluted according to needs) is a 10 per cent solution, to which sulphuric acid is slowly added, in order that it may be diluted with water without risk of forming a basic salt, in the proportion of 4 c. c. of the acid to 100 c. c. of the solution. This proportion of acid does not exert any unfavorable action on the film, because it forms finally a salt with very slight acid reaction.

The 10 per cent solution acts very energetically, but notwithstanding this energy, does not attack the film so as to cause it to run in places when the negative is held up to the light for examination—such a frequent accident with potassium ferricyanide. The rapidity of the action can be regulated by diluting the liquid more or less.

If a rapid reducer is desired, acting more quickly on the more opaque parts of the plate than on those more transparent, the 5 per cent solution of ceric sulphate can be used.

Summary.—Among the maximum salts capable of directly reducing the silver images, those of cerium peroxyd alone seem to present valuable properties. The ceric sulphate solution, it seems to us, ought to be substituted for the Farmer liquid, which not only cannot be kept in solution, but has other defects, from which the ceric sulphate is completely exempt.

As to the chemical reactions of different salts at maximum on the silver prints, all act by dissolving the silver in a part of the acid of the maximum salt in proportion as this is changed to a minimum salt, according to an equation analogous to the one we have given above for ferric salts.

The reaction is produced in all probability whenever the heat from the formation of the maximum salt is lower than the heat from the formation of the silver salt. Thus it is possible to explain why certain maximum salts reduce the silver images when others having the same acid are without action.—MM. Lumière Brothers and Seyewetz, in Moniteur Scientifique.

SOLID LUBRICATING OILS.

LYES will facilitate the solidification of lubricating oils without the employment of water, by reacting on them with the aid of perfectly dry alkaline bicarbonates, or of neutral carbonates, uniformly at a temperature varying between 90 degrees and 130 degrees C.

According to their nature they are taken either in their commercial condition or, after treatment, resin is added, oxidized or not.

If, for example, almond oil is taken, it is heated, 3 per cent of resin in solution is added, and afterward an excess of alkaline bicarbonate; then the whole is heated to 110 degrees C., keeping it in motion for two hours, after which the superficial scum is removed, and the mass is placed in a filter heated to the same temperature. Then an oil will pass through the filter, identical with that employed at the outset,

which, on cooling to 50 degrees C., will solidify in the form of a transparent sirup, resembling jelly, but much more firm.

It will be insoluble in chloroform, and will possess all the lubricating qualities of the original oil. But if 6 per cent, instead of 3 per cent, of resin is added, the oil will not become solid, even if the heating is prolonged for eight or ten hours, the reaction being probably prevented by the excess of resin.—Translated from Les Corps Gras.

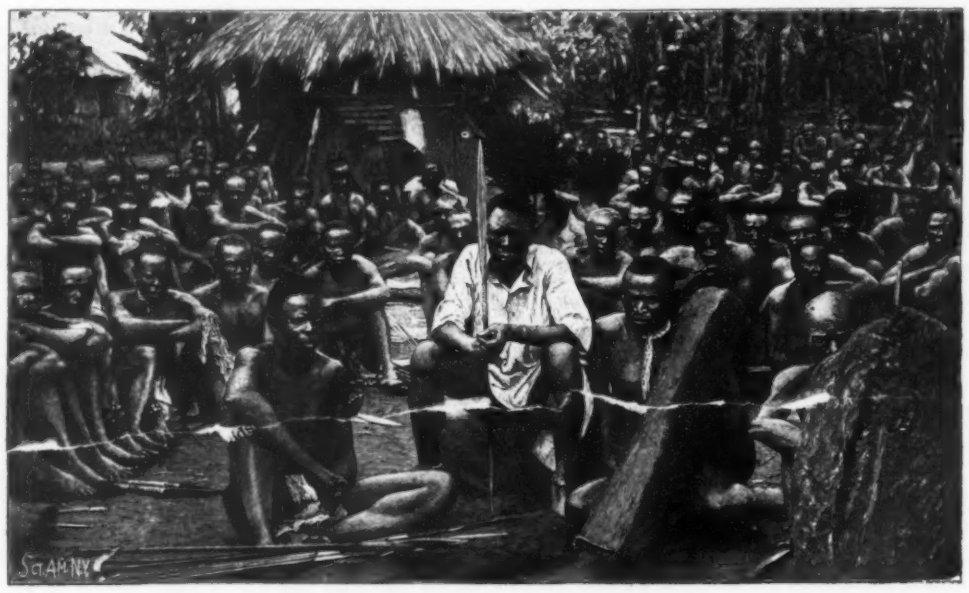
RUTEGANIS—THE NEW HOUSE.

KONDELAND IN GERMAN EAST AFRICA.

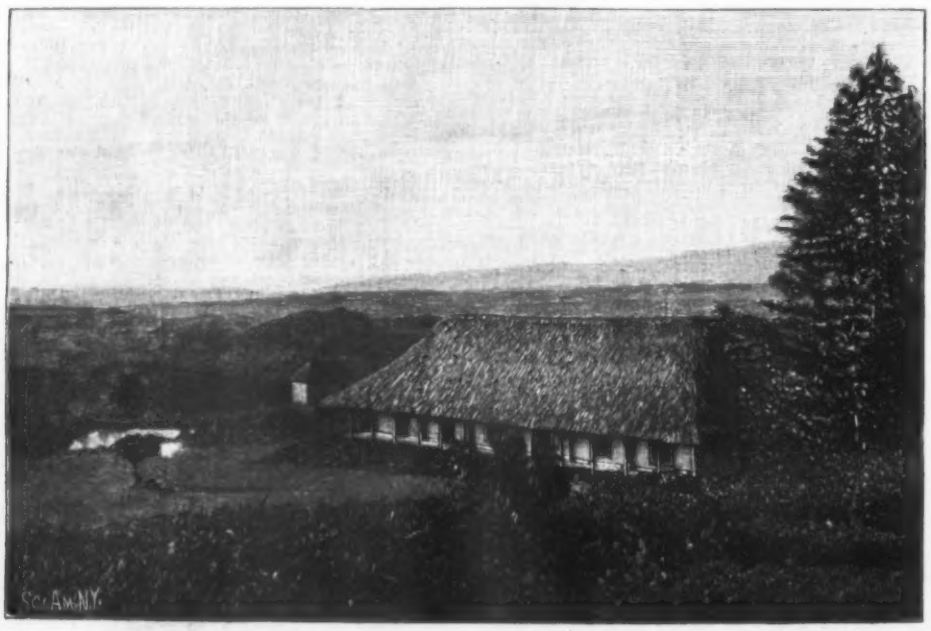
KONDELAND, occupying the southwestern portion of the German East African possessions north of Nyassa, was first explored by the English, but has become known largely through the efforts of German missionaries. As soon as Germany secured possession of the land, the missionaries drew correct maps, studied the people and the language, and collected the folklore. For ten years these missionaries have labored. After they had opened up the country they were followed by German colonists who forthwith established the station of Langenburg. Two German steamers, "H. v. Wissmann" and "Paulus," now ply upon Lake Nyassa. The blacks have so far been influenced by missionaries and government agents the land is even now rapidly developing and will soon become one of the most important of the German African possessions.

Kondeland has an advantage over less remotely situated regions in so far as it is connected with the ocean by Lake Nyassa, the rivers Schire and Zambesi. The six German and English steamers plying upon these waterways are hardly able to meet the demands of the trade. A large twin-screw steamer has been ordered from an English firm for the passenger traffic.

Kondeland has an area of about 2,500 square kilometers (964 square miles), and has a population of a hundred thousand. On the west and east the region is bounded respectively by the Bundale and Livingstone Mountains, both of which ranges meet in the north. Mt. Rungue, the highest mountain in the land, rises to a height of 2,500 meters (8,200 feet); at its foot is the main station of the missionaries, bearing the same name. The many brooks and rivulets of the mountains flow together to form the three main streams Kiwira, Mbaka and Lufira. The land along the lake is composed largely of alluvial deposits, and is of unusual fertility and, therefore, rather thickly populated by the blacks. The whites, who are more susceptible to fever than the natives, have not settled in these lowlands, but have established themselves at stations on the lake at Ipiana and Icombe, the former of which may in time become of considerable commercial importance owing to the presence of coal. As the traveler proceeds inward, the land rises to a wide plateau. Of the beauty of the landscape, so extravagantly praised by travelers, something may be gleaned from our illustrations.



A TRIBAL COUNCIL AT MUAMPURU.



THE MISSION CHURCH AT RUNGUE.

The rainfall here is heavy; the highest mountains are almost constantly capped with fog. As a result the vegetation is most luxuriant. Villages may be detected from afar by reason of their large banana groves and their well cultivated fields planted with sweet potatoes, Kaffir corn, maize, and various kinds of beans. Even on the plateaus the soil is so fruitful that two or three harvests are reaped in a year. Still more fertile are the lowlands; for here, during the rainy season, a portion of the ground is submerged and, therefore, well adapted for the cultivation of rice.

The wealth of the inhabitants consists of cattle, sheep and goats. During the night the animals are stabled in long sheds; during the day they roam freely, the clear tinkling of the bells around their necks being heard afar. Cattle-stealing was formerly a most common crime; even to this very day men buy their wives with cattle, or give them to their guests or pay the fines which are imposed for petty offenses by the German government agents. The climate of the plateaus is healthy and by no means so hot as one may expect. During the rainy season the land is almost deluged. In Manow, one of the stations of the Berlin mission, the rainfall in April, 1893, was 979 mm.; in Germany the rainfall for the whole year was not more than 770 mm. On certain days the rainfall in Manow was as much as 184.5 mm.

The inhabitants are a strong, intelligent race. Although they practise the art of weaving, they clothe themselves merely in breech clouts; the missionaries, however, have succeeded in introducing a light form of clothing of more generous proportions. Both men and women wear the hair quite short. Further to the south, men and women lavish more care upon their headdress, as one of our illustrations shows. The only form of vanity to be found among the women is the habit the brides have of dyeing their hair a fiery red. The men sometimes wear rings on the thigh, and both men and women are proud of their beautiful teeth which they clean with soft wood.

The Konde are a harmless, good-natured race, tractable and courteous. The white man who visits the village is greeted by the first native who may see him, with bows, clapping of hands and with the words, "Welcome, white man!" If the traveler desires to remain in the village for a time, a mat is immediately brought for him. When he has seated himself he is greeted a second time and begged to remain and to refresh himself before he proceeds on his journey. Questions are asked as to his well-being; "How have you slept? How has your head slept? How have your limbs slept? How have your friends slept?" etc. The Konde are not distrustful, but frank and open in their relations with the white man. Indeed, the whites are considered higher beings. The natives, being an agricultural people, know little or nothing of aught but animals and the tilling of the soil.

The wants of the people are singularly few. Time and time again Europeans have marveled at the endurance and cheerfulness of the native carriers. Among the pleasures of the people may be mentioned the smoking of tobacco, which they cultivate themselves. They are moderate in their use of alcohol, so that drunkenness is almost unknown among them. They delight in the maintenance of order. The round huts made of bamboo poles, covered by a thatched roof, are kept well cleaned. The village streets are swept each morning by boys.

For many years the land about Lake Nyassa has been visited by coast slave dealers and fearful depredations committed among the people. It would have been easy enough for the natives to band together and sweep their opponents before them; but they contented themselves with fleeing to the highlands and there preserving their independence. The tribe is governed by no single chief; the inhabitants are distributed in small independent groups or tribes, each of which has its particular chief. Of these chiefs those near the lake wield the greatest power and are often able to gather about them as many as 6,000 warriors. The chiefs are not rulers with unlimited power, but are assisted in their regal duties by a council of old men. Sometimes it happens that this council is stronger than the chief, and may even depose him. In time of great danger or when matters of importance are to be discussed the entire male population meets in council.

The lack of a strong organized government, which is one of the prime requisites for the development of a refined civilization, has not been without its evil effects. Through the influence of European culture, however, the primitive life of the inhabitants must

soon change. The government agent now exercises full judicial powers. Quarrels are settled not by force but by law. Peace and security reign in the land. A few years ago slave caravans journeying through Kondeland to the coast were sometimes attacked. Now all travelers may journey in safety.

Although polygamy is practised, the position of woman is not by any means low. The relation between parents and children is particularly tender. The religion of the people is not idolatry; they believe in a great, good invisible god who has created the world. He is never pictured and indeed plays no very important part in their life. Only in time of great misfortune is he called upon. Then the people go into the woods and cry "Mbamba, let our children grow, our cattle multiply, the fruit of our fields flourish!" Thereupon they chew leaves, drink beer and blow it through the leaves into the air. This "blowing to God," as they call it, usually ends with a feast. More important than the good god is the evil god Mbasi, whose influence the natives seek to divert by sacrifices of meat, milk and beer. Particularly unfortunate is it when Mbasi enters the body of a man and so empowers him to destroy others, to draw the milk from his neighbor's cows, and to send sickness into houses. If suspicion falls upon any who is supposed to harbor the spirit of the evil god he can counteract the evils which he has committed by drinking muafi, a light poison which is usually not attended with harmful results.

The missionaries enjoy the full confidence of the Konde. Up to the present six stations have been established. The missionary force numbers in all twenty-three, including the women. Converts are made rapidly. At the central station of Rungue is a Christian village of twenty huts and sixty inhabitants. The church is built after the style adopted by the missionaries in the construction of their own houses; the walls are made of bricks upon which an overhanging grass roof is placed. The church likewise serves as a school. A new style of architecture will soon be introduced; for the missionaries are convinced that it is hardly advisable to build houses with thatched roofs, which cannot withstand the inclement rainy seasons for more than five years.—R. Meyer, in Illustrirte Zeitung.

THE DIAGNOSIS OF PLAGUE.*

I HAVE no doubt that the plague expert, who has seen epidemic plague in the East, will think it unnecessary on the part of a bacteriologist to ask, What is plague? for is not plague, as it occurs in China, India, at the Cape, and other parts weekly, nay, daily, by the score of cases, quite readily diagnosed by its clinical features and by its pathology? No one can have any doubt about this being so; that is to say, when plague appears in a locality in epidemic form, the diagnosis of any new case does not offer much difficulty; nor would there be experienced much difficulty in diagnosis by etiological, clinical, pathological and bacteriological methods of a case, or of cases, occurring in a ship coming from a plague-infected port: as, for instance, the cases that occurred in connection with a vessel which arrived about the middle of January in the port of Hull—cases which belonged to the pneumonia type, and which from the outset were, or ought to have been, at once diagnosed as such.

The difficulty in diagnosis commences when you have a single or a first case occurring, where either the etiological data are not satisfactory, or where the clinical history and symptoms are not distinct and not typical. The cases of two sailors recently examined illustrate these two difficulties.

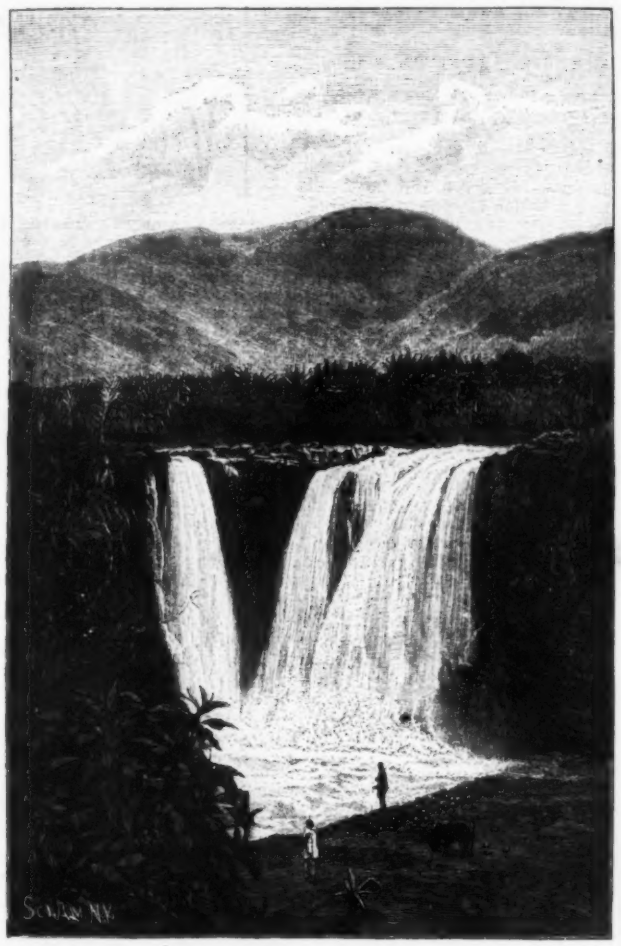
The outcome of the bacteriological analysis o. one sailor who arrived in London in October, 1900, was that the case was plague. In the second case a plate made with a small droplet of pus from a swelling yielded, besides staphylococci and streptococci, a considerable number of colonies of the *bacillus pestis*. Tests by subcultures and animal experiments (both as subcutaneous and intra-peritoneal injections) proved this conclusively.

A third case is that of a boy that had recently occurred in one of the London hospitals. This much is certain, that the boy suffered from an illness the symptoms of which to a large degree were compatible with true plague; that etiologically no satisfactory evidence was forthcoming to elucidate the disease. The bacterioscopic evidence, which in certain respects supported the diagnosis plague, in another essential respect—animal experiment—negatived it; and I would particularly draw attention to the total absence of any microbes in the pus of the suppurating bubo of the boy in the later stages of his disease, and to the total absence of agglutinating action of his blood in the convalescent stage.

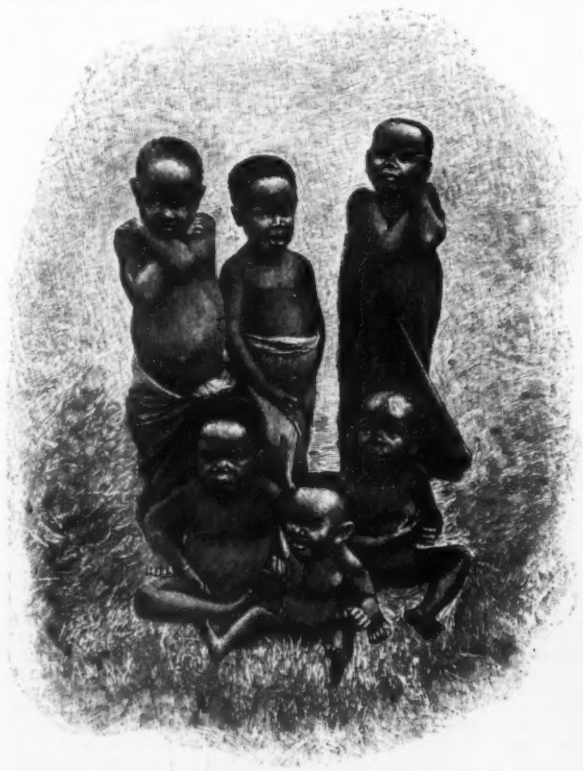
Apart from the difficulties in diagnosis of isolated cases, there are to be gathered, I think, several interesting and instructive facts from the cases hitherto mentioned.

In the first place, it is a fact that neither of the ship-borne cases mentioned above gave rise to infection in other persons, although during the whole journey they were freely intercommunicating with other members of the ship's crews. It will be no doubt said that *pestis ambulans*, the mild form with which, at any rate, one of those two cases compares, is known to possess only slight infectivity, and this infectivity might be referable only to the matter of the open and discharging bubo. In the two cases mentioned the number of *bacilli pestis* were still considerable, and in one at least of the cases there was a history of severe illness previous to arrival in English ports. And I would, in this connection, express a *prima facie* strong skepticism as to the alleged high degree of infectivity of the bubonic type of plague in general. In the case of the pneumonic and septicæmic type, a high degree of infectivity is in complete accordance with the bacteriological facts and with the wide distribution of the plague bacilli in, and the copious discharge from, the body of the patient. In the pneumonic type, the exudation of the inflamed lung and the expectoration teem with the plague bacilli; in the septicæmic or hæmorrhagic form the blood contains an abundance of the bacilli, hæmorrhages occur in the membranes of the alimentary, respiratory and urinary

* Abstract of a paper read before the Epidemiological Society on Friday, May 17, by Dr. E. Klein, F.R.S.



THE FALLS OF KIWIRA.



THE SMALLEST FREED SLAVES

FREED SLAVE WOMAN.

HAIRDRESS OF SOUTHERN KONDE.

organs; and therefore the voiding of plague bacilli is extremely great and their diffusion easy. But in the bubonic form, in the early phases of the disease, plague bacilli are rare in the blood; they are practically limited to the spleen and lymph glands, and as long as these latter do not open I do not see how they can be the agents of further infection. In the urine and in the alimentary canal they certainly cannot be demonstrated in a living state in this form of the disease. When the lymph glands, after the acute stage is passed, suppurate and open, then, no doubt, plague bacilli can and do become available.—Nature.

[Continued from SUPPLEMENT, No. 1328, page 21288.]

SYNTONIC WIRELESS TELEGRAPHY.

By GUGLIELMO MARCONI.

IT is easy to understand that if we have several receiving stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them, without danger of the message being picked up by the other stations for which it is not intended. But, better than this, we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers. Different messages can be sent by each transmitter connected to the same radiating wire simultaneously, and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe to be quite novel, I showed to several friends of mine, including Dr. Fleming, F.R.S., in the summer of last year, and to an Admiralty Commission. Dr. Fleming has made mention of the results I showed him in a letter to The Times dated October 4, 1900, and in his Cantor lectures delivered before the Society of Arts in November and December, 1900. A further improvement has been obtained by the combination of the two systems. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly tuned induction coil, and all circuits must be tuned to the same period as already described. (See Fig. 16.)

The tuning of the receiver to respond to the period of the transmitter, as used in the old form of transmitter shown in Fig. 1, or in the new one shown in Fig. 7, has enabled results to be obtained over considerable distances with moderate heights.

As already published by Dr. Fleming in the letter above referred to, signaling has been successfully carried out over a distance of 50 kilometers with a cylinder only 1.25 meters high, 40 inches in diameter.

This has led to the possibility of constructing portable apparatus for army purposes, which should be of great service in the field. I have succeeded in constructing a complete installation on a steam motor car, of which I here show a photograph. On the roof of the car, as you may observe, there is placed a cylinder which can be lowered when traveling, its height being only six or seven meters, and by this means communication has been easily carried out with a syntonized station over a distance of 31 miles. A 25-centimeter spark induction coil worked by accumulators and taking about 100 watts is used for transmitting, and the accumulators can be recharged by a small dynamo worked by the car motor. I believe such an appliance might have been of use to the besieged garrisons in South Africa and China.

A strip of wire netting laid on the ground is sufficient for earth connection, and by dragging it along communication can be established, even when the car is traveling. I have recently obtained as good results by not using any "connection" to earth, but only utilizing in lieu of earth the electrical capacity of the boiler of the motor car. I also find that signals can be transmitted a considerable distance with the cylinder in a horizontal position.

Last spring I recognized the desirability of carrying out tests between stations situated at much greater distances apart than had been attempted heretofore.* A station was established at the Lizard, Cornwall, and on the first attempt communication was effected with St. Catherine's, Isle of Wight, over a distance of 186 miles, which I believe is the record distance over which signals have been sent through space without wires. It is interesting to observe that signals were obtained over this distance with the transmitting apparatus as shown in Fig. 1, or with the arrangement shown in Fig. 7, provided always that a suitable resonating induction coil was employed at the receiving station.

The amount of energy used for signaling over this distance is not more than 150 watts, but experiments with a larger amount of energy will shortly be carried out. In the case of the 186 miles transmission, the aerial conductor consisted of four parallel vertical wires, 1.50 meters apart, 48 meters long, or in a strip of wire netting of the same length.

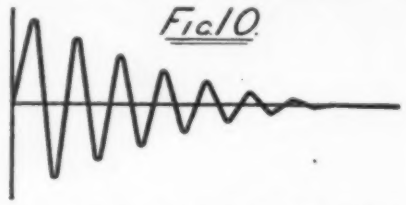
It is interesting to note that in order to communicate between my stations at Poole and St. Catherine's (distance 31 miles) with the same amount of energy and the same kind of aerial wire, this must be 20 meters high to obtain signals of about the same strength as those obtained between the 186-mile stations with the 48-meter aerials.

This goes to confirm many other results previously obtained, which indicate that with a parity of other conditions the distance varies with the square of the height of the vertical conductors at the two stations. I have always found this law fulfilled, if the height of the conductors at the two stations is approximately equal, although an attempt has been made recently to throw doubt upon its correctness.

You will admit that the progress achieved in syntonic space telegraphy must have enormously increased its field of application and usefulness, since a very great number of non-interfering stations can now be worked in the immediate vicinity of each other.

It will probably be of interest if I give you a few examples of the progress made in the practical utilization of my system. An eminent electrician recently expressed a doubt whether there was at present a single circuit worked commercially on a practical system of wireless telegraphy.*

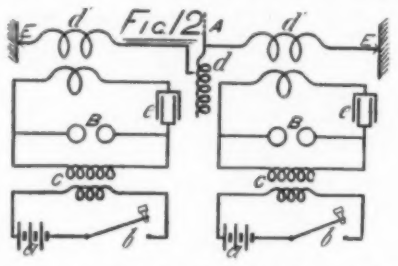
If earning a revenue from working installations can be termed a commercial working, even such an incomplete list of these as time will now permit me to give you, and which are now all in permanent



working order, may be sufficient proof that a beginning at least has been made in the commercial utilization of the system.

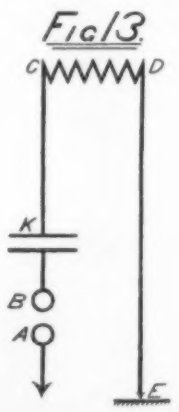
In March, 1900, there were in use in the Royal Navy in South African waters five installations of my system. The Admiralty was apparently well satisfied with its working, since in May of last year they decided to extend its adoption to thirty-two more ships and land stations. The conditions of the contract were that each apparatus, before being accepted, should be satisfactorily worked by naval signalmen between two ships anchored at Portsmouth and Portland, over a distance of 62 miles, a considerable portion of which—i. e., 18 miles—lies over land, with

intervening hills; and the height of aerial wire was specified not to exceed on each ship 49 meters. The apparatus was delivered in a comparatively short time, no sets having been found unsatisfactory. The apparatus supplied to the Admiralty is so far all of the old pattern—i. e., the non-syntonized system—and I have been informed that messages have been transmitted and received by naval signalmen between ships more than 160 kilometers apart. It sometimes occurs that the unfamiliarity of the operators with the particular kind of apparatus used caused unsatisfactory results to be obtained, but I believe this trouble will soon disappear. I am glad to be able to state that arrangements are being made to install my new syntonic appa-



ratus upon several of His Majesty's ships. I believe that in no other navy in the world is wireless telegraphy being worked regularly over such considerable distances. My system is also used for communication between the Borkum Riff and Borkum lightship, in Germany, where an ordinary commercial charge is made for messages received from ships, and it is employed further on the Nord Deutscher Lloyds mail steamer "Kaiser Wilhelm der Grosse."

According to an official report of the Imperial postal authorities of Oldenburg, the total number of commercial wireless telegrams transmitted from and to the lightship between May 15 and the end of October amounted to 565, and of these 518 came from ships



at sea, while 47 were transmitted to ships. Of the 518 telegrams 35.7 per cent were addressed to the North German Lloyd, and 64.3 per cent to other shipping firms.

The installations are worked by ordinary operators in a most satisfactory manner, and on one occasion assistance was obtained for a man who was taken suddenly ill on the Borkum Riff, and it was thus made possible to hand him over promptly for medical treatment on shore.

The system has been in operation at La Panne, near Ostend, and on the Belgian mail steamer, "Princess Clémentine," which plies to Dover. With a height of only 22 meters on the ship it has been found practicable to communicate from Dover Harbor to La Panne, 43 miles away, and this installation has proved of value in saving life and property. Thus, recently a barque was wrecked on the Rattel Bank. The "Princess Clémentine," which happened to pass near, at once sent a message to Ostend, and before leaving was able to tell the shipwrecked sailors that assistance was on the way. The men were all saved.* On another day, coming within sighting distance of the Ruytingen Lightship, situated about 15½ miles from Dunkirk, the captain of the "Princess Clémentine" observed that he was being signaled. It appears that the lighting apparatus of the Ruytingen had gone out of order. The captain of the mail packet immediately dispatched a message, which was received by the installation at La Panne, and repeated to the lighthouse department at Dunkirk. A crew immediately set out for the lightship and effected the necessary repairs, and the great inconvenience and danger of the lightship not being able to have the lights in order was averted.

Another instance of the usefulness of the wireless telegraphy in an emergency was furnished when the "Princess Clémentine" herself went ashore on the Belgian coast during a fog. Within a few minutes of the accident news of it was telegraphed from the stranded ship to Ostend, with the result that a tug was at once dispatched to her assistance, and she got off at the next high tide. So successful has the installation of wireless telegraphy been on the mail steamer "Princess Clémentine," between Dover and Ostend, that similar apparatus is to be fitted on the other vessels of the same fleet.

The system has been in use, furthermore, since March 1 last, for ordinary commercial telegraphy between the Sandwich Islands, where a regular charge is made for the same. An installation has also been successfully carried out by my assistants for the French government, between Antibes, in France, and Corsica, a distance of 124 miles.

As has already been published in the daily papers, much use has been made of my system in the navy during the voyage of the Duke and Duchess of Cornwall and York to Australia.

I have tried lately to ascertain how near a tuned transmitter, which is radiating waves of a certain frequency, must be to a receiver, tuned to a different frequency, in order that the said receiver shall be affected. I find that if we are working with oscillations which differ very considerably in period, a transmitter capable of sending signals 31 miles to a tuned receiver will not affect a non-tuned one at 50 meters. If the periods of oscillation of the two tunes are more similar to each other, then the non-tuned receiver may be affected even at several kilometers.

Considerable use is still made of the non-tuned system at my experimental stations, in order to be able to communicate with ships fitted with what I call the old system, and also in order to be able to communicate with the Naval Station at Portsmouth.

Before concluding, I wish to say a few words on a method proposed by Prof. Slaby, and with which I have also carried out some experiments. As transmitter, Slaby uses an arrangement as shown in Fig. 13, which consists of a vertical conductor, in which is interposed a condenser, *K*, and a spark gap, *B*. The top of the wire is not free, but is connected to earth through an inductance, *C D*, and a wire *E*.

At the receiving station the arrangement shown in Fig. 17 is employed. It consists in a vertical conductor, *D C*, connected to earth at *C*, which should be the nodal point of the waves induced in the wire, *D C*, where there is joined another wire, termed an extension wire, of equal length.

In this case Slaby places an apparatus which he calls a "Multiplicator," connected to the coherer between the end of the extension wire and the earth, or by another arrangement (Fig. 17); he uses a loop wire, *F G H D C E*, the multiplicator being placed between *E* and *F* in series with the extension wire, *J*. By means of this arrangement, Slaby, on the 22d of December of last year, showed the reception of two different messages sent from two transmitting stations situated at unequal distances from the receiving station to be possible, one station being at 4 kilometers and the other at 14; thus obtaining a result which may be considered similar to that obtained by me some months previously over larger distances (see Prof. Fleming's letter in The Times of October 4, 1900). The information given in Slaby's paper, as published in the Elektrotechnischen Zeitschrift, is exceedingly incomplete.

We are not told what was the amount of energy used for the transmission nor the height of the vertical conductor at the receiving station or at the transmitting station at the Aberspree Kablewurks. We are only told that the transmission wire was suspended between the chimney shafts. Very little information is given as to the appliance which Dr. Slaby calls a multiplicator. G. Kapp, who is probably acquainted with the details of Slaby's work, commenting on this paper of his, calls the instrument in question "an especially wound induction coil ('Induction-spule'), the function of which is to increase the E. M. F. of the oscillations at the ends of the coherer." Upon reading this for the first time, I assume that the multiplicator was an oscillation transformer performing the function of those described in my patent, dated June 1, 1898, and also described in my Royal Institution lecture of February 2, 1901. As I subsequently, however, discovered, Prof. Slaby, referring to the multiplicator, states: "This apparatus in its most simple form consists of a wire coil of a determined shape and form of winding, which depends upon the length of the wave. . . . I might call this apparatus, unknown to my knowledge up to the present, a multiplicator. It is not to be confounded with a transformer, as it has no secondary winding."

This statement appears to me very ambiguous, as I

* See Electrician, February 15, 1901, page 609.

* See the Electrician, November 30, 1900, page 211, and editorial article, page 205.

* See Electrician, March 15, 1901, p. 907.

always have understood that what we call transformers need not have a distinct secondary winding. An appliance called an auto transformer was used by the Westinghouse Company for regulating the E. M. F. supplied to house lighting installations, which consisted in a single winding, a certain number of turns acting inductively on the adjacent ones. (See "The Alternate Current Transformer," by J. A. Flem-ing, vol. 2, pp. 187, 188.)

One of the first transformers ever made is shown in the work above referred to, vol. 2, pp. 6 and 7. At page 6 we read: "Page really made the first experiment in auto-induction and showed that different parts of the same conductor might act as primary and secondary circuits to each other, if in contiguity."

I installed the apparatus described by Slaby at Niton, Isle of Wight, and at Poole, using wires 35 meters high, but with the receiving wire earthed at *C* (Fig. 17) of the loop, I could receive nothing, although I tried various frequencies of oscillation. It is, however, probable that I might have received, had I been working over much shorter distances than 50 kilometers, as Slaby did in his demonstration, or had I used a greater height of wire.

By using, however, my method of connection, i. e., introducing between the vertical wire and earth an oscillation transformer, having its circuits tuned to the frequency given by an ordinary vertical radiating conductor of length equal to the Slaby wire, *A C*, I succeeded by means of extremely sensitive coherers in obtaining communication. I then tried the following experiment. I took down the earth wire, *E D*, and the inductance, *D C*, and used only the conductor, *A C*, insulated, with the condenser in circuit for transmitting. An enormous strengthening of the signals at the receiver was immediately obtained, which obviously means a greater ease of working, and the possibility of obtaining signals over greater distances. The reasons which demonstrate that a closed circuit, such as is employed by Slaby, must be a poor radiator, are obvious to those who have studied and read the classical works published since the time of Hertz's experiments.

Dr. Slaby, however, states that the inductance at the top of his loop confines the oscillations to the vertical part, *A C*. If this be the case, the frequency of these local oscillations cannot be equal to that of the whole circuit, *A C D E*, which it has been stated was so easy to calculate, if the translations of Slaby's paper I am relying on are correct.

I believe that notwithstanding the inductance, *C D*, a considerable amount of energy must pass to earth through the earthed wire, which acts as a leak uselessly dissipating energy which should be radiated into space in the form of ether waves.

If these conclusions are correct, I am not at all clear as to what necessity there is for employing the earthed conductor, *E D* and the inductance.

It is not necessary for obtaining syntonic effects from transmitting stations placed at unequal distances from the receiver, as these can be obtained when using the primitive form of transmitter shown in Fig. 1, and Slaby has not yet described how to obtain different messages from transmitters situated at equal distances from the receivers, which is much more difficult in my experience, nor does it appear possible with the method he describes to transmit various messages at the same time from one sending wire as can be done with the system I have just explained.

The distance obtained with the closed transmitting arrangement must be comparatively small.

As I have already stated, communication over a distance of 300 kilometers is now being maintained with my system, but I am not aware of anything approaching even 100 kilometers being achieved with the loop transmitter. It may be said that long distances of transmission are not necessarily an advantage, but I notice that the navy wants long distance apparatus supplied to it.

I have also tried connections similar to Slaby's extension wire in the receiver, but I find that the real sifting out of waves is done in the oscillation transformer, although sometimes it may be desirable to increase the period of oscillation of the aerial conductor by adding inductance to it, or at other times to decrease the period by placing a suitable condenser in series with it.

I trust it will not be thought that I wish in any way to minimize the importance of Slaby's work. I only wish to get at the facts and to draw a discussion on a very interesting subject.

Time does not permit me to refer to a great number of experiments upon which I am now engaged, or which have been carried out by others, but I hope on a future occasion to describe better results.

I have come to the conclusion that the days of the non-tuned system are numbered. The ether about the English Channel has become, in consequence of great wireless activity, exceedingly lively, and a non-tuned receiver keeps picking up messages or parts of messages from various sources which very often render unreadable the message one is trying to receive. I am glad to say, however, that I am now prepared with syntonic apparatus suitable for commercial purposes.

And, as my final word on the general subject for the present, let me say that those who are responsible for the recent development of wireless telegraphy into a practical science, cannot fail to find great satisfaction in the reflection that, as already life has been saved that without this discovery would have been lost, so, in the future, apart from its manifold commercial possibilities, valuable as these are, humanity is likely to have before very long to recognize in telegraphy through space without connecting wires the most potent safeguard that has yet been devised to reduce the perils of the world's sea-going population.

DISCUSSION.

Dr. Fleming, F.R.S., said that as he had been permitted to be a little behind the scenes, and had seen some of the apparatus before it was made public, he was able to entirely confirm Mr. Marconi's statements with regard to his experiments. A very great stride forward had been made in syntonic telegraphy. The subject was not a new one, in fact, a large number of patents had been taken out in connection with it, most of which, however, embodied more hope than experience. In spite of the fact that there were so many claims of priority in the matter, he had the strongest possible conviction that Mr. Marconi was the first person to actually achieve a true syntonic telegraphy with electric waves. He had done that in

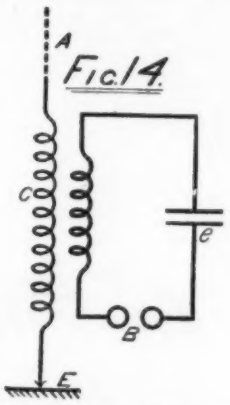


FIG. 14.

virtue of having followed out to their logical issue the fundamental scientific principles of the subject which he had so clearly grasped, one of which was the essential distinction between the radiative and the non-radiative circuits. Many inventors and patentees had professed to have obtained syntonic telegraphy with a simple open aerial insulated radiator of the Marconi type. Although it was possible to produce a kind of bastard syntonic telegraphy by that means it was not possible to produce true syntonic telegraphy, because the aerial simply produced a sort of

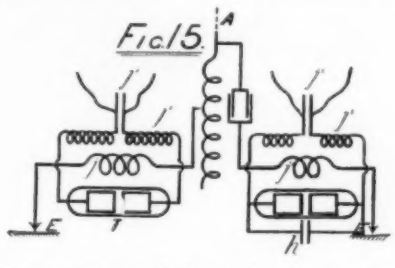


FIG. 15.

ætheric impulse or explosion, and not a true train of waves. It was just as possible to produce true syntonic telegraphy by those means as it would be to cause one whip to crack by cracking another one near to it. When a closed circuit was taken, which was a powerful absorber of electric energy, and associated with a radiative circuit, a means was obtained for producing a true train of waves. If those two circuits were tuned together, a great improvement was effected on anything previously accomplished. Mr. Marconi had not only constructed a receiver capable of receiv-

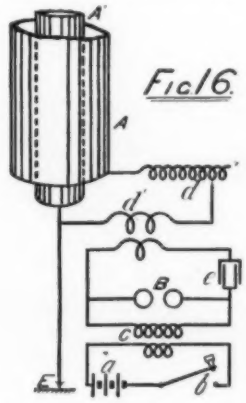


FIG. 16.

ing trains of waves, but also capable of not receiving those not adapted to it. No train of waves would act upon his syntonic receiver except those which had a particular period. An analogy might be found in a cork floating on water, which would be bobbed up and down by any wave, long or short, which went over it; but a heavy log of wood floating on the water and tethered to the bottom of the sea by a spiral spring would only be caused to bob up and down by waves having one particular period. The former corresponded to a simple coherer, and the

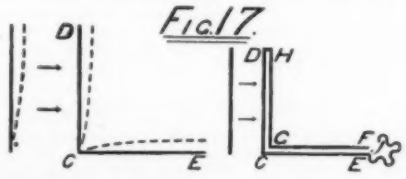


FIG. 17.

latter to a syntonic receiver of the kind described in the paper. He quite agreed with Mr. Marconi that the days of the non-syntonic telegraphy were numbered, because no one would choose a receiver capable of being affected by every vagrant wave, when such an instrument as Mr. Marconi's latest form of receiver was available. Among the possibilities which lay in front of the invention was that it would be immediately possible to provide the Admiralty and the Post Office with instruments having an Admiralty or Post Office frequency, and to register frequency just as a telegraphic address was registered, so that no one else could use that particular frequency. He had had the privilege of riding on the motor-car described by the reader of the paper, and, when miles from home, they were able to communicate with their hotel and order their lunches. In conclusion, he offered his warmest congratulations to Mr. Marconi on the immense strides he had made in the improvement of his initial invention.

Capt. Kennedy said he wished to explain, in common justice to Mr. Marconi, some of the points connected with the operation of the system in South Africa. A scheme was suddenly conceived and hastily executed of sending apparatus and assistants to install the system at Durban. But instead of setting it up at that port, it was sent to the front. No poles were available, and the attempts to substitute kites and balloons were unsuccessful. For want of labor and proper materials progress was slow, and eventually the work was stopped. On arriving in Natal, on the first opportunity, he handed the whole system over to Captain Percy Scott, who worked it most satisfactorily on board the ships at Durban up to the time he left South Africa. The operations in Cape Colony were entirely experimental, and would have succeeded had they been given a fair chance.

The Chairman, in proposing a vote of thanks to Mr. Marconi for his admirable paper, said that, after listening to what wireless telegraphy had already done in saving life and ships, they realized why the reader of the paper, although so young, had acquired fame, why he had won that more substantial reward which sometimes went with fame, but often did not, and also grasped why he had earned what should be dearer to him than fame or wealth, the gratitude of the people for having so courageously developed a new sense for the world. Although still far away, he thought they were gradually coming within thinkable distance of the realization of a prophecy he ventured to make four years ago, of a time when if a person wanted to call to a friend he knew not where, he would call in a loud, electromagnetic voice, heard by him who had the electromagnetic ear, silent to him who had it not. "Where are you?" he would say. A small reply would come, "I am at the bottom of a coal mine, or crossing the Andes, or in the middle of the Pacific." Or, perhaps, in spite of all the calling, no reply would come, and the person would then know his friend was dead. Let them think of what that meant, of the calling which went on every day from room to room of a house, and then think of that calling extending from pole to pole; not a noisy babble, but a call audible to him who wanted to hear and absolutely silent to him who did not, it was almost like dreamland and ghostland, not the ghostland of the heated imagination cultivated by the Psychical Society, but a real communication from a distance based on true physical laws. On seeing the young faces of so many present he was filled with green envy that they, and not he, might very likely live to see the fulfillment of his prophecy.

The resolution was carried unanimously.

Mr Marconi, in reply, thanked Dr. Fleming for his kind remarks; to him he was also indebted for valuable advice on many subjects he did not understand, and in which Dr. Fleming's theoretical knowledge was of great value. In reference to Capt. Kennedy's remarks, he wished to give an explanation. When the war broke out in South Africa he was asked whether he could send his apparatus out there. His associates, in reply, made two proposals: (1) To send apparatus for work at the Front, and (2) between shore stations and the transports at Durban. The proposal of using the apparatus at the Front was not accepted by the War Office at the time. The apparatus was sent out without poles because he was informed they would be found at Durban. On the arrival of his assistants in South Africa they pluckily volunteered to go to the Front, thinking the system might be worked with advantage to the English army, but on reaching the Front poles could not be obtained by which to raise the wires. At that time, according to his old-fashioned system, this was absolutely necessary. Capt. Baden-Powell came to the rescue with some well-designed kites, and signals were transmitted about 18 miles. Although the system was never used during operations in South Africa, it was not the fault of the system. In conclusion he thanked the Chairman for his remarks, and hoped he would be able to improve considerably on what he had done and obtain more valuable results for land and sea purposes. He wished also to thank the Council of the Society of Arts for asking him to read the paper, and the audience for the kind way in which they had appreciated his efforts.—Journal of the Society of Arts.

CONTEMPORARY ELECTRICAL SCIENCE.*

ELEMENTARY QUANTITIES OF MATTER AND ELECTRICITY.—Boltzmann has represented the entropy of a monatomic gas by the logarithm of the probability of its state, and shown that

$$\int \frac{dQ}{T} = \frac{2}{3}\Omega = \frac{2}{3}\log P,$$

where dQ signifies the heat introduced from without (in mechanical units), T the mean kinetic energy of an atom, and $\Omega = \log P$ the natural logarithm of the probability of the stationary distribution of velocities among the atoms, measured by the number P of possible "complexions." M. Planck adds that in his own electromagnetic theory of radiation he obtains for the entropy of a large number of linear resonators oscillating independently in a steady-radiation field the expression

$$\varkappa \log R,$$

where R is the number of possible "complexions," and $\varkappa$ the number 1.346×10^{-5} erg-degrees. Combining these two principles, he finds the following values: Weight of the atom 1.64×10^{-24} gramme; number of gas molecules in 1 c. c. at 0 deg. and 1 atmosphere, 2.76×10^{19}; mean kinetic energy of an atom at abso-

* Compiled by E. E. Fournier d'Albe, in the Electrician.

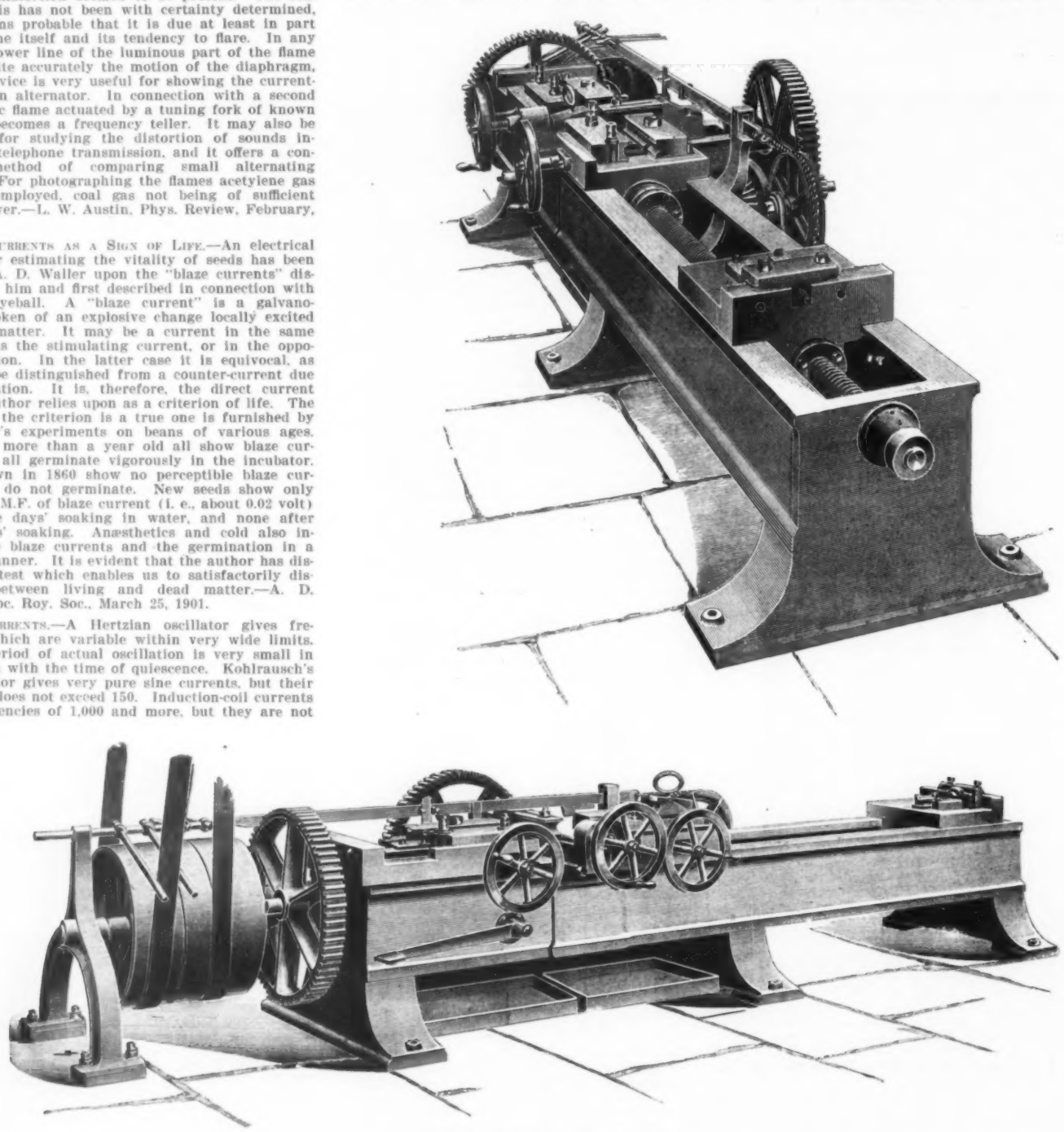
lute temperature 1 deg., 2.02×10^{-16}; charge of a positive monovalent electron 4.69×10^{-10} electrostatic units. These values, if the theory holds, are very much more definite than anything yet given, and the constant κ is the weakest point in the calculation.—M. Planck, Ann. der Physik, No. 3, 1901.

MANOMETRIC STUDY OF THE TELEPHONE.—Since Merritt has shown the possibility of photographically registering the variations of manometric flames, the sphere of usefulness of this very sensitive reagent has been very greatly increased. L. W. Austin has applied this method with considerable success to the study of the motion of telephone membranes. A jet was inserted through a rubber cork cemented into the opening of a telephone cap, and another hole was drilled in the cap through which the gas was introduced, thus making a manometric capsule of the telephone itself. The apparatus was tried with a number of different alternators and the curves from all of these showed their own peculiarities of form, though a certain distortion seemed to be present. The reason for this has not been with certainty determined, but it seems probable that it is due at least in part to the flame itself and its tendency to flare. In any case, the lower line of the luminous part of the flame follows quite accurately the motion of the diaphragm, and the device is very useful for showing the current-curve of an alternator. In connection with a second manometric flame actuated by a tuning fork of known period it becomes a frequency teller. It may also be employed for studying the distortion of sounds inherent in telephone transmission, and it offers a convenient method of comparing small alternating E.M.F.'s. For photographing the flames acetylene gas must be employed, coal gas not being of sufficient actinic power.—L. W. Austin, Phys. Review, February, 1901.

BLAZE CURRENTS AS A SIGN OF LIFE.—An electrical method for estimating the vitality of seeds has been based by A. D. Waller upon the "blaze currents" discovered by him and first described in connection with a frog's eyeball. A "blaze current" is a galvanometrical token of an explosive change locally excited in living matter. It may be a current in the same direction as the stimulating current, or in the opposite direction. In the latter case it is equivocal, as it cannot be distinguished from a counter-current due to polarization. It is, therefore, the direct current that the author relies upon as a criterion of life. The proof that the criterion is a true one is furnished by the author's experiments on beans of various ages. Beans not more than a year old all show blaze currents, and all germinate vigorously in the incubator. Seeds grown in 1860 show no perceptible blaze currents, and do not germinate. New seeds show only half the E.M.F. of blaze current (i. e., about 0.02 volt) after three days' soaking in water, and none after four weeks' soaking. Anæsthetics and cold also influence the blaze currents and the germination in a parallel manner. It is evident that the author has discovered a test which enables us to satisfactorily distinguish between living and dead matter.—A. D. Waller, Proc. Roy. Soc., March 25, 1901.

SINE CURRENTS.—A Hertzian oscillator gives frequencies which are variable within very wide limits. But the period of actual oscillation is very small in comparison with the time of quiescence. Kohlrausch's sine inductor gives very pure sine currents, but their frequency does not exceed 150. Induction-coil currents have frequencies of 1,000 and more, but they are not even approximately sinusoidal. Hummel's continuous-alternate-current transformer gives frequencies of 400 to 500, but even those are not sufficient for demonstrating resonance phenomena. M. Wien has therefore devised a method of producing sinusoidal alternate currents with frequencies as high as 8,500 $\sim$ per second. In these currents none of the higher components have an amplitude exceeding 1 per cent of the main amplitude. The latter is 0.2 ampere with a resistance of 100 ohms, and that suffices for most measurements. For experiments in which the currents need not be very purely sinusoidal, double the frequency may be produced with the same apparatus, viz., 17,000 $\sim$ per second. The principle of the apparatus is the following: A disk of wood or brass carries a number of pieces of transformer sheet-iron round its rim, and the latter moves between the poles of an electromagnet. The alternations thus generated are reinforced by what the author terms "electric resonance," which consists in bringing the proper period of the electric system into unison with the frequency by inserting a suitable capacity and regulating the inductance. By this device the amplitude of the main current is greatly augmented, while the overtones remain small as before.—M. Wien, Ann. der Physik, No. 3, 1901.

COHERERS FOR WIRELESS TELEGRAPHY.—A satisfactory coherer must be uniform in its action. Its sensitiveness must be great and must vary but little from time to time. The final resistance of the coherer must fall below some predetermined value after each signal, but it need not be low, as the relay can be adjusted for any value desired. C. Kinsley, in specifying the requirements of a good coherer for wireless telegraphy, points out that however much uncertainty attends the use of the wireless telegraph it need not be due to the coherers. He emphasizes most strongly the fact that the sensitiveness does not depend on the metal or metals employed. Coherers of any degree of sensitiveness desired may be made of any metal. It is only necessary to treat each metal in accordance with its peculiar nature. The limit of sensitiveness is defined by the difference of potential which must always be present between the coherer terminals whenever a relay is used. This should always be kept as low as possible to preserve a safe working margin, and thus to prevent any local disturbance from producing a false signal. The best difference of potential seems to be 0.4 volt; as the current must also be kept small—say, less than 0.002 ampere—a very sensitive relay should be used, operated, say, by a current of 0.001 ampere.—C. Kinsley, Phys. Review, March, 1901.



CRANK-BENDING MACHINE.

CRANK-BENDING MACHINE.

THE machine which forms the subject of our illustration, says Engineering, is constructed by Messrs. Dent & Holt, Limited, of Bridge End Works, Burnley, for forming cranks out of solid bars of iron, and also forming collars on shafts out of the solid bar, and has been supplied by the above firm to some of the leading textile machinists, for making cranks and tappet shafts, etc., for weaving looms.

The bars to be cranked are cut off to dead lengths, and heated at the place where the crank sweep is to be formed; they are then placed lengthwise on to the machine, and secured instantly by the dies on each side of the portion heated. These dies are made to suit the different diameters of the bars to be cranked, and are bolted to very strong slides. A strong cross-slide and screw forms the internal part of the crank. While this operation is being performed, the two end blocks on the machine (which are worked by means of the very strong right and left hand screw running the entire length of the machine) push up the ends of the bar. The machine is set in motion by means of the foot-lever shown on the front, thus leaving the operator with both hands at liberty. When one crank is formed, the machine automatically reverses and stops, ready for the next. There are special facilities afforded on this machine for regulating the strength of the sweep of the crank, and also the corners of the sweep, which may be left the same thickness as the bars, or thicker or thinner as desired.

From thirty to forty sweeps can be made per hour, according to the skill of the operator.

By changing the dies on this machine, and substituting some specially constructed collaring dies, collars may be formed on solid bars, thereby effecting a great saving in doing away with the process of welding on loose collars as formerly. In the operation of forming the collars the cross-slide is not brought into use, but the bar is placed between the dies, and the metal is forced into a recess in one set of the dies, the size of the collar to be formed.

THE COMMERCE OF JAPAN.

THE commerce of Japan, in which the United States is greatly interested, is discussed by the Swiss Consul-General at Yokohama in a report which has just reached the Treasury Bureau of Statistics. It shows a steady increase in the importations of Japan in 1900 over those of the preceding year, though in the matter of raw cotton there has been a marked decrease. Japan's importations of raw cotton in 1899 were very large and, owing to the higher price in 1900 and the large stock of American cottons laid in during 1899, her imports of that single article from the United States in the nine months ending with March, 1901, have been but $1,729,580 in value, as against $11,517,968 in the corresponding months of the fiscal year 1900. As a consequence the total figures of our exports to Japan show a material decrease,

chargeable, however, almost exclusively to the single item of cotton. Even with this great reduction our total exports to Japan in the nine months for which the Bureau of Statistics has completed its figures of the present fiscal year are nearly two million dollars in excess of the corresponding months of the fiscal year 1899, though, as above observed, less than those created by the abnormal importation of American cotton in the fiscal year 1900.

The following statement of commercial conditions in Japan is taken from the report of the Swiss Consul-General above referred to:

"Owing to the recent political troubles, Japan's foreign trade in 1900, unlike preceding years, shows a considerable falling off. Money has been scarce, one bank after another has had to suspend payments, and the Japanese merchants, unable to find a market for ordered goods, simply break their contracts. It is reported that there are at present goods to the value of about $20,000,000 which have been ordered but not taken by Japanese merchants and manufacturers.

"The imports as compared with those of the preceding year have been higher by about $33,000,000, while the exports have been lower by $5,500,000. This means for Japan an outflow of over $40,000,000. It is hoped that after the end of the Chinese troubles, which impose upon Japan altogether excessive sacrifices, a turn to the better may take place. The total value of the foreign trade in 1900 was $243,791,000, an increase of $27,000,000 over the figures of 1899. This increase is due chiefly to the extraordinary demand for rails and other iron products, woolen cloths, sugar and petroleum. The exports show a decrease of $5,500,000, chiefly owing to the depression in the trade of raw silk, 'kaiki,' matches, and cotton yarns."

PORTABLE MILL MOUNTED ON A CART, AND OPERATED BY PUSHING THE LATTER.

THE two wheels of the cart, *A A*, and the small toothed wheel, *B*, being fast on the axle of the cart, all turn together when the cart is being pushed; and as the wheel, *B*, engages the lantern wheel, *D*, the latter and the millstone mounted on the same shaft with it will turn also. The axle, *C*, is fastened to the handles of the cart by iron straps, in which, however, it turns freely. The wheels have spikes on the tires to allow of their gripping the earth and not slipping when the cart is being pushed.—From Recueil d'Ouvrages Curieux de Mecanique et de Mathematique.

FIREPROOFING OF FABRICS AND OTHER MATERIALS.

INTERESTING comparative experiments on incombustibles have been made by M. Giraud at the Paris Municipal Laboratory before officials of the city, of theaters, of the police, miners, engineers and others.

Upon a large table were placed some theatrical accessories, fabrics, gauze, turkey-red, papers, paintings, awnings, velvets, plushes, tapestries, felt, artificial foliage, with and without the fireproof protection. Flame was successively applied to all these objects. The fabrics and accessories not fireproof blazed at once, but the objects which had been chemically prepared were merely blackened and at most only partly consumed.

The test made upon a little fireproof umbrella of tissue paper was very curious. Despite the persistency of M. Sanglé-Ferrière, in holding it in the strong flame of an alcohol lamp, the paper was only blackened.

Other tests were made on spruce boxes with sides of 22 c. c., fitted with a cover, in which four holes were bored, which served as a chimney. These were filled with wood shavings.

The boxes, with the exception of one kept for comparison, had received applications of ammonium phosphate, boric acid, sodium silicate, amianth, alumina, borax, ammoniacal salts, products employed by different manufacturers of non-combustibles. Box No. 4, prepared according to the Laboratory formula of two coats of sodium silicate and one of amianth, furnished the best results. The other processes were efficacious; but the wood, without being consumed, was more or less attacked.

Another box, prepared with ammoniacal salts and borax, fixed in the wood by electricity (a preparation used for all the wood in the construction of the French Theater), exhibited equal protection.

M. Giraud then passed to the treatment of the scenery. After a non-fireproof decoration had blazed in ten seconds, a decoration partially fireproof was exhibited. On a blazing hearth, fitted with shavings, the fireproof part only was not consumed. The flame licked its edges, but neither the painting, nor the frame took fire. They were not even blackened.

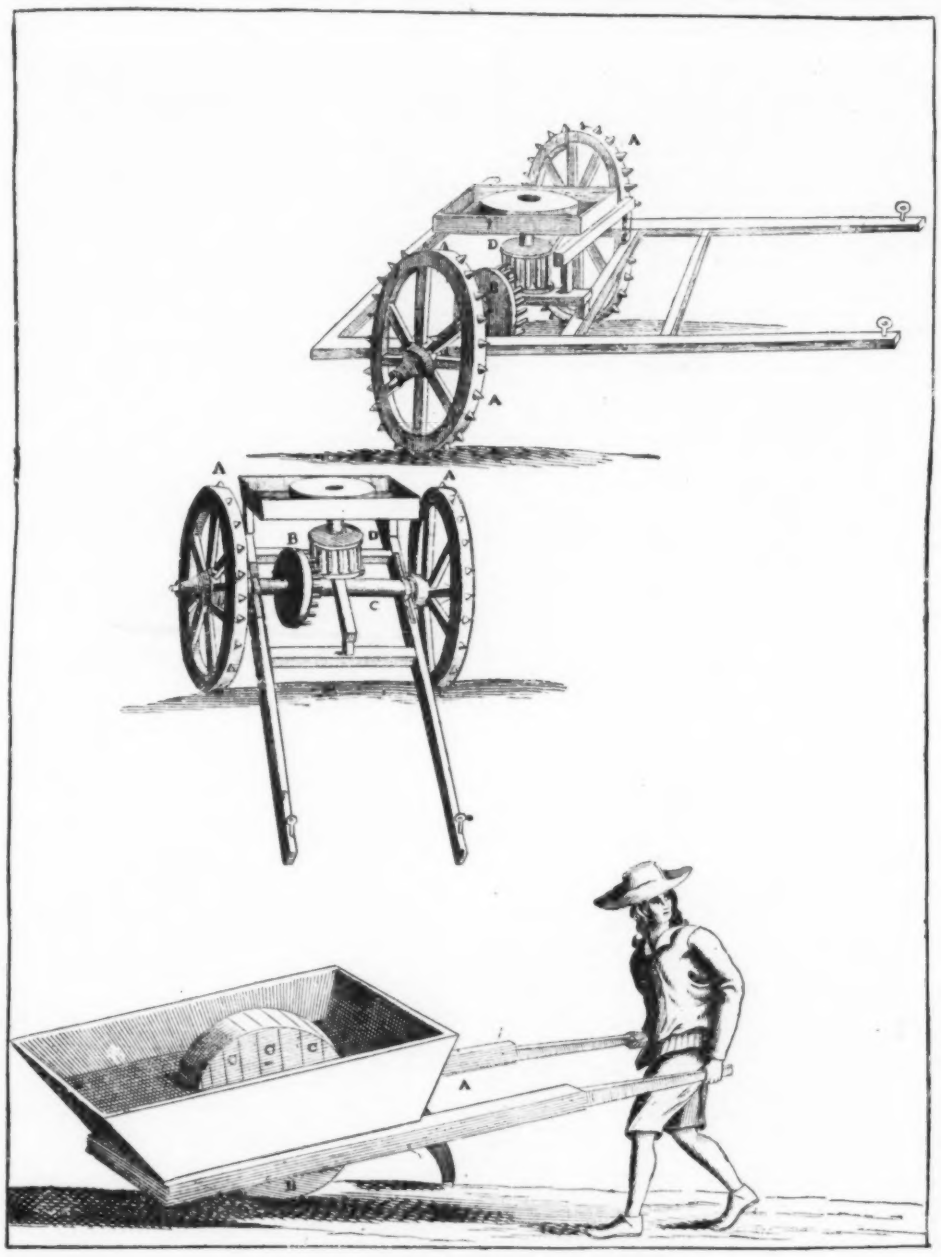
Then an artist's canvas, previously prepared with the fireproof mixture, was exposed to the flame, and it was impossible to set it on fire.

This series of experiments ended with the demonstration of the utility of wood treated by electrolysis for the covering of electric wires.

It was shown that notwithstanding the intensity of the current, the short circuits could not communicate fire to the wood-work.

These extremely interesting experiments of M. Giraud were suggested by a fire occurring in one of the galleries of the Esplanade des Invalides. If the hangings had not been previously made fireproof by the service of the Municipal Laboratory, the fire would have extended throughout the building. But only a movable banister not fireproof, and whose use had not yet been authorized, was destroyed.

It is now demonstrated that absolute incombustibility can be assured for woodwork, hangings and fabrics of various kinds.—Translated from La Nature.



PORTABLE MILL OPERATED BY PUSHING.

PROTECTION OF FERRIC STRUCTURES.*

By M. P. WOOD, New York, Member of the Society.

1. THE last thirty years have worked a revolution in the construction, armament, and equipment of the navies of the world by the substitution of iron and steel in the place of wood. This change is of equal moment in the design, materials, and construction of the merchant marine, also of the thousands of railway bridges, viaducts, public buildings and other structures now so essential to the necessities of modern life. This change from wooden construction to iron and steel has centered around it the best minds and efforts of modern times, and may be taken to represent the concrete civilization of a thousand years. The impulse is onward and upward to a still higher plane, and with our rapidly decreasing forests and timber supplies, and the rapidly narrowing margin in the difference of cost between a ferric structure and one built of wood, it may not require another equal period of time to see nearly all of our domestic structures built of metal instead of wood, with a greater security from risk of fire to add to the many other advantages in the change.

2. But our knowledge or rather our methods for the preservation of ferric bodies from corrosion have not kept pace with our knowledge and methods of construction, and the consequence is that in thousands of ferric constructions, from the least to the greatest, after a brief existence, we find corrosion has gained a footing, and the structure instead of having an assured life of centuries is measured by that of a few decades. It may be stated almost without question, that not 30 per cent of the ferric structures of any kind or character in the United States have ever received a protective coating which is worthy of its name; per contra, that the very first steps taken with a view to prevent corrosion, whether at the shop during manufacture or at the site while being erected and covering in, are radically wrong, and have been so demonstrated by actual experience for thirty years in thousands of instances and locations, and yet not a few of our eminent construction and railway engineers fail to draw either lesson or deduction from the past failures of their predecessors' work, and blindly repeat them. At the risk of renewing a thrice-told tale, I propose to review some of the notable instances of failure to protect our ferric structures from corrosion, as well as to note some instances of success, trusting that the review may cause a more rational treatment of a matter on which depends the security of thousands of lives and thousands of millions of dollars' worth of property.

IRON OXIDE PIGMENTS.

3. Probably at this date iron oxide pigments, either in their natural condition, as ground red or brown hematite iron ores, or the same as a base to which a score of other substances are added by the paint compounding manufacturers, have been more generally used than any other pigments, natural or compound, for the protection from corrosion of ferric structures, and to the extended and careless use of them under their many trade names may be attributed the corrosion in ferric structures that greets the eye, go where one may.

4. The color of these paints varies from a dark, dirty purple brown to a bright dark red—the Indian red of commerce. Their color is due to the processes of roasting, grinding, and subsequent doctoring of the product to get a desired color tone. A few degrees more or less of heat, or a few seconds more or less exposure to the same, evolve a great diversity in the color even if the composition of the pigment remains unchanged.

5. Analyses of some of these hematite ores are given which will convey in some measure the heterogeneous character of the substances in the native ores, from which to select one which will embrace the claim "to never fade," "never wear out," "always protect any wooden or ferric body from fire, rot, corrosion, or wet, regardless of situation or condition."

ANALYSES OF BROWN HEMATITE (ANHYDRATED) IRON ORE.

Twenty-four different ores by different analysts.

Ferric oxide	90.05	to 32.74	Averages,	59.54	Eleven samples averaged metallic iron 32.35 per cent. Thirteen samples averaged metallic iron 38.81 per cent.
Ferrous oxide	traces	" 50.54	"	1.22	
Manganese oxide	3.06	" 0.05	"	0.87	
Alumina oxide	27.95	" 0.05	"	4.48	
Lime oxide	0.06	" 25.70	"	4.20	
Magnesia	0.17	" 10.21	"	1.30	
Silica	63.52	" 0.79	"	13.90	
Carbonic acid	0.16	" 18.45	"	3.83	
Phosphoric acid	0.06	" 3.17	"	0.63	
Sulphuric acid	traces	" 0.28	"	0.03	
Iron pyrites	traces	" 0.30	"	0.03	
Water hygroscopic and combined	18.60	" 6.60	"	10.25	

Percentages of metallic iron, 63.04 to 24.09. Averages, 42.45.

ANALYSES OF RED HEMATITE (ANHYDROUS) IRON ORE.

Twenty different ores by different analysts.

Ferric oxide	98.71	to 66.55	Averages,	89.13
Ferrous oxide	traces	" 1.13	"	0.16
Manganese oxide	9.13	" 0.19	"	0.31
Alumina oxide	2.79	" 0.06	"	0.82
Lime oxide	9.40	" 0.07	"	1.97
Magnesia oxide	1.39	" 0.06	"	0.42
Silica	8.90	" 1.00	"	5.77
Carbonic acid	5.73	" 0.78	"	1.35
Phosphoric acid	1.02	" traces	"	traces
Sulphuric acid and iron pyrites	1.31	" "		"
Water hygroscopic and combined	2.12	" "		"

Percentages of metallic iron, 69.10 to 47.47. Averages, 62.37.
Specific gravities, 3.80 to 5.33.

* Presented at the Milwaukee meeting (May, 1901) of the American Society of Mechanical Engineers.

6. With this wide variation in the composition of the above iron ores, selected not only on account of the metallic iron in them, but also for the small amount of lime, magnesia, carbonic, phosphoric, sulphuric acids and pyrites, what may not be inferred as to the composition of the other iron oxide mines whose product, used for pigments instead of smelting purposes, have 20 to 40 per cent of ferric and ferrous oxide, with greater amounts of silica, lime, magnesia, sulphuric and other acids, pyrites and water? As a rule the lower the amount of metallic iron in the ore the greater is the amount of the latter substances, which are not only detrimental for smelting purposes, but are also much less acceptable for a protective covering for either wood or iron, and whose decorative qualities lie principally in the direction that they do not look as bad as something else. Now, the process of roasting these hematite ores for pigments is with a view to the color, and to expel the water, sulphuric and other acids in them. But this roasting does not expel all the sulphur and other acid elements, only about one-half of whatever amount of these acids may be in the ore under treatment, even if the heat be long continued, which would ruin the color. The balance of the SO_3 and CO_2 and other acids are only excited by the heat to a greater activity to restore a disturbed condition of their composition; besides, the lime and magnesia are rendered caustic and, when mixed with the oil carrying more or less uncombined water in it, slake the same as lime slakes in a mortar bed and set up a chemical action in the freshly applied paint which, if it does not delay the drying of the coating, must have some effect upon the same, which from experience we know to be detrimental. To neutralize the sulphur element natural to the ore or developed in roasting, it is the common practice to add carbonate of lime (common chalk) to the amount of 5 to 10 per cent by weight of the iron oxide, which combining with the sulphuric acid, changes to a synthetically formed sulphate of lime (gypsum) which, however inert as a pigment and admirable as a stuffing, is not as desirable in this form as the natural gypsum would be. This change from a carbonate to a sulphate is wholly a chemical one and takes place only when in the presence of and in contact with the oil, and is exerted at the critical moment of the first drying of the coating, and as it is not an instantaneous combination, the chemical action continues even after the paint has set and necessarily must affect the whole character of the coating, particularly the menstruum, the decomposition of which may be said to have commenced before it was fairly dry or even put on. This chemical change is accompanied by an increase in volume of the carbonate, acting as a mechanical force upon the coating, as will be hereafter noted.

7. The value of iron oxide paint as a protective coating for any ferric structure has been forcibly presented in a paper, No. 752, vol. xxxiii., Transactions American Society of Civil Engineers, June, 1895: "Painting of Iron Structures Exposed to Weather." This paper is a report of a special examination of the condition of the protective coatings on a large number of important railway bridges, viaducts, etc., many of which had been constructed and delivered as finished structures; the preservative methods employed being (as stated), in most cases, selection of the bridge-construction firms.

8. The evidences of corrosion on these structures had become so serious as to attract attention even in the few years that they had been erected, and to ascertain their actual condition one of the bridge staff of engineers was detailed. He reports visiting twelve locations and fifty-three structures of greater or less importance, thirteen of which were painted with an iron oxide paint, trade marked "Cleveland Iron-Clad Paint, Brown Purple No. 3," which, from the analysis given on page 521 (his report), is a hematite ore from the Lake Superior region, unroasted and not distinguishable from hundreds of other red or brown hematite iron ores, except as being very rich in sesquioxide of iron, viz., 93.04 per cent, equal to 65 per cent metallic iron combined with 28 per cent oxygen. Every pound of this pigment carries three times as much oxygen as a pound of red lead pigment, and a gallon of red lead paint would have to contain 23 1-3 pounds of red lead pigment to equal the oxygen element in 7½ pounds of this iron oxide paint, and yet the advocates of the latter paint prate loudly of the awful combustion of the oil as a consequence of the use of red lead, presumably to cover the deficiencies of their own compositions as protective coatings. (See forward, Smith's paint test.) No analysis of the engineer's own firm's iron oxide paint is given, nor does he mention (except in a single instance) the structures which he examined as having received his firm's special paint, but mentions that a patent paint was used on some of the structures which consisted of about 33 per cent of iron oxide and 60 per cent of silica. What the remaining 7 per cent was composed of is not stated, but presumably it was a chalk stuffing.

9. Eleven of the 53 structures mentioned were coated with oil at the shop, and received two coats of iron oxide paint when erected. Included in this number are the Blair Crossing Bridge (especially under the examining engineer's own care during erecting, and painted with his firm's own iron oxide paint), the Rulo and Leavenworth bridges, and St. Louis Elevated Railway structures. The condition of these structures as described ought to set at rest forever the utter worthlessness of an oil coating as the foundation coat for any paint on an iron structure, even if the other seven coil coating examples did not bear testimony to the same effect—*but they did*. Twenty-two bridges reported upon were painted with iron oxide at the shop and received two coats of the same paint after erection, and obviously are in no measure an improvement upon the eleven above noted, and all are a sorry record of the means employed in past day engineering to protect important ferric structures from corrosion. Six of the bridges had received red lead coatings; 5, red lead as first coat and iron oxide external coatings. The condition of these structures, as well as 9 others painted with unknown or uncertain pigments, were evidently no worse than those of the iron oxide class, and all showed the general failure of contracting and in-charge engineers' methods to properly protect their work from elemental destruction.

10. The physical condition of these 53 structures in no measure sustains the engineer in his final deductions in favor of iron oxide paints as against red lead or other paints, or that an oil coating was the best foundation for the other coatings, or that raw linseed oil is superior to properly boiled linseed oil as a menstruum; conclusions that the members of the A. S. C. E. who took part in the discussion of the paper, both orally and by correspondence, were overwhelmingly against. The condition of these bridges is probably a fair representation of a majority of the railway bridges in the United States, the greater number of which have received the same or a similar treatment against corrosion which has proved to be inadequate for that purpose in the instances reported, and similar conditions would be found to be the case in hundreds of other bridges erected and painted prior to 1895, if examined and reported upon in detail.

BOILED OIL VERSUS PIGMENT COATINGS.

11. Many eminent engineers have abandoned the use of iron oxide and other uncertain patent paint compounds, but still adhere to the use of oil for the first coating. The writer believes this method will bear fruit at no distant day in as calamitous a corrosive result as has attended the use of iron oxide, particularly in the case of all suspension bridge cables, anchorage bars, lattice trusses, and other inclosed places where inspection or replacement is practically impossible. Certainly, a pigment coating can be applied anywhere and as easily as an oil coating, will dry as quickly and as hard, and at any stage of drying will resist mechanical injury due to handling, transportation, and erection better than the oil coating, and if storms of any character reach the coating, as they certainly will, they will not so injuriously affect it, either in a minor or major degree, as they do an oil coating. Finally, if the oil coating is so supremely good for the foundation coat, why not extend the goodness and make *all* the coatings of oil alone, and save the cost of the pigments in the subsequent coats, and retire the whole corps of paint compounders and salesmen to the shades where rest the remains of the lamented iron oxides? The protective qualities of an oil coating compared with a paint are forcibly shown by Dr. Dudley's experiments for the Pennsylvania Railroad, viz.: Several samples of paint were made from raw linseed oil and a small quantity of japan, the same vehicle and pigment being used for all the samples with varying amounts of pigments, all the proportions being by weight. Two coats of these paints were spread upon glass, and each allowed to harden for two weeks. The samples were then placed side by side and a small portion of the surface of each was covered with a globule of water which was covered to prevent evaporation, and then allowed to stand for twelve to fourteen hours.

Sample No.	1	was the linseed oil and japan alone.				
"	2	was the same liquid	90	parts,	pigment	10 parts.
"	3	" "	80	"	"	20 "
"	4	" "	70	"	"	30 "
"	5	" "	60	"	"	40 "
"	6	" "	50	"	"	50 "
"	7	" "	40	"	"	60 "

At the end of the period the condition of the samples was as follows: No. 1 had cleaved off from the glass and had shriveled wherever the water had touched it. On allowing the water to evaporate the coating dried down again, but not uniformly. It was weakened in texture and had apparently lost its bond to the glass.

No. 2 showed the same characteristics.

No. 3 showed the same but in a less degree.

No. 4 did not cleave from the glass, but showed where the water had stood.

No. 5 showed a spot in the same way, but in a less degree than No. 4.

Nos. 6 and 7 showed but very little action beyond a slight discoloration.

What more evidence need be presented to show that the use of oil alone for the foundation coat is radically wrong, and the sooner abandoned the more to the credit of modern day engineering practice? No theory that the oil alone will soak into or beneath the loose, or partially loose, scales and rust on the body coated is tenable in the face of the fact that these scales and rust must be removed to secure a favorable result with any coating. There is absolutely no excuse for allowing them to be coated over, or incorporated into any coating. Doctor Dudley's results are in direct line with and corroborate the tests of Prof. Smith, Toltz's, and others hereafter given.

12. Rust proceeds solely from the action of an acidulated moisture upon a bright or clean iron surface, and is probably only a point at its inaugural. The affinity of the iron for the oxygen in the acidulated moisture of the air or water in the oil, or from other sources, is greater than its bond with the hydrogen as water (H_2O); the decomposition ensuing releases the hydrogen, which is 16 times the volume of oxygen united with the iron to form hydrated Fe_2O_3, or red rust. The hydrogen, from its light specific gravity, in its effort to escape into the air, pushes up the overlying paint coating, increases the area of the affected part, cracks the coating in its exit, moisture enters again, and corrosion is master of that location. The rust which has thus been formed is hygroscopic and carries 24 per cent of moisture as it forms. This moisture *never dries out* under any atmospheric heat conditions, but is ever ready for a chemical decomposition, the hydrated red rust formed, being over two times the volume of the iron from which it is formed, adds its efforts to the free hydrogen to push up the coating and form a blister and crack in the coating. How energetic this mechanical action due to corrosion is, may be observed by noting the ordinary cast-iron hand railings for fences and outside steps of New York city and other city houses, which in hundreds of instances are split for more or less of their length. Cast-iron water or gas pipes, with bell and spigot joints, are frequently made with rust joints. They almost invariably burst the bells by the swelling of the iron cement used to make the joint.

13. Late advices as to the condition of the great cantilever bridge over the Firth of Forth,* Scotland (finished less than 10 years ago), show that corrosion is well and widely established over the entire structure, notwithstanding a corps of painters are continuously employed upon it, and the structure is practically repainted every three years and in many places yearly. Upon the lower parts, where the iron work rests upon the masonry, and upward where the spume and salt spray from the sea reaches the work, corrosion has attacked the rivet heads and laps of the angles, channel bars and plates, and cannot be controlled by the scraper and paint brush. This structure received two coats of boiled oil at the shop before erection, and then two coats of iron oxide paint, each of which required 90 tons of paint. It is the opinion of the writer that before the bridge has had thirty years of existence it will have to receive the drastic action of the sand blast for all parts which can be reached by that process, and that even that will not wholly remedy the evil. That the lower sections for 20 or more feet in height from the masonry piers will be so corroded they will have to be cut out and renewed, if they can be. That thousands of the rivets, many of them 1¼ inches to 1½ inches diameter by 9 inches in metal, will be so corroded under their heads as to have lost their set. In fact, the stability of the bridge in the future will rest quite as much upon its mass as upon the mutual strength of its connecting members. Some one was knighted for the ability shown in the construction of this bridge; it may be that somebody else will get *two* buttons on his bonnet for being able to take care of it.

NEW YORK ELEVATED RAILWAY VIADUCT.

14. The viaduct over the Harlem Station of the New York Elevated Railway at 155th Street was oil-coated, and received oxide of iron paint coatings at the time of its erection, and within five years of its completion had developed corrosion to such an extent that in 1897 the sand blast was used to clean it preparatory for another effort for its preservation. This sand blast process cost about $10,000, or over fifteen cents per square foot to apply, or about seven times as much more than a properly selected method of procedure and paint would have cost in the first place, and then only the lower and accessible sides or parts in sight received treatment, while the top side, out of sight and, from its inaccessibility for inspection, more important to protect, got no sand blast and corrosion was left free to run riot. About 50,000 square feet of surface was cleaned by the sand blast to the bright iron, removing about 12 tons of old paint, scales of rust, and cinders, showing a number of distinct layers of highly corroded matter. Full particulars of the air blast mechanism, illustrated, are given in the Engineering News September 23, 1897; also Engineering Record, September 25, 1897.

15. Seventeen panels of lattice truss, floor beam and buckle plates, supporting the paved carriage roadway and footpaths overhead, about 2,825 square feet of surface each, and numbered consecutively 1 to 17, were then painted with the same number of selected protective coatings furnished by a like number of paint firms in competition with each other. The several coatings were applied in strict conformity to the directions received with each brand of paint, the application being to the bright iron as left by the action of the sand blast, and within three or four hours from the time the sand blast ceased action, the paint being spread by the painters employed by the Board of Public Works of New York city. Every possible condition was brought into bearing to make the test one of a practical and commercial nature as well as of scientific value, absolutely without prejudice or favor in any respect. From the prominence of the structure in an engineering view and its situation, exposed to storms, sea air, fog, cinders, steam, and gases from scores of locomotives in constant service beneath it, nearly all the metal being within a few feet of the tops of engine stacks and receiving the products of combustion under blast action and in an approximately closed space, the future result was anxiously looked for as an important demonstration of the practical value of the several best protective coatings in the market.

After an exposure of about nine months, and while a few of the coatings, viewed from the station platform, showed evidences of failure, a thorough examination of the condition of each panel was made by a prominent engineer under orders of the Board of Public Works, New York city (see Engineering News, May 24, 1898). This report is of extreme interest and value to engineers, and is summarized, viz., 100 rating as a perfect condition of the coating.

16. Panel No. 1 was an outside one, and the first to be sand blasted and painted with three coats of paint in the clear hot days of summer, a material advantage in its favor. The sand blast was then shifted to the southern end of the viaduct; and panel No. 17, also an outside one, was the next one cleaned and painted in hot clear weather, and so on consecutively, in the reverse order of the panel numbers, back to No. 1; panels Nos. 7 to 2 having been done late in the fall under unfavorable conditions as to the spreading and drying of the paint, in addition to the other objectionable conditions. About 80 square feet of panel surface was cleaned per hour, or 600 square feet per working day; each panel requiring from five to six days to clean and paint it.

17. It will be noticed that panels No. 1 and No. 5, rating in the best condition, each received three coats of paint, while all of the others (except panel No. 10) received only two coats; the high ratings of these panels may in a measure be attributed to this extra coat. But panel No. 1, also Nos. 9, 12 and 13, while rating high as to the non-appearance of rust, yet the actual condition of the coatings in being rotten, easily removed, crumbling under touch of the fingers, indicated a poorer condition to resist corrosion on a longer exposure than panels Nos. 2, 4, 5, 6, 7 and 14, which may be considered as being in an approximately fair condition, and far better coatings than those rating higher, but in a rotten condition.

18. Panels No. 1 (97 per cent) and No. 3 (25 per

* Trans. A. S. M. E., December, 1894, vol. xvi., paper No. 625, pp. 407-408.

Number of Paint.	Number of Coats of Paint.	Kind or Name of Paint.	Rate of Drying.	Freedom from Rust, Per Cent.	Reference Marks as to Condition.
1	3	Lead, graphite and lucol oil	Medium	97	*a*
2	2	Amorphous graphite, Detroit Co.—L. S. G.	Slow	80	*b*
3	2	Red lead, antoxide, F. and D.	Fast	55	*c*
4	4	Graphite (kind not stated)	Slow	75	*d*
5	3	Nobrac (trade mark)	Medium	99	*e*
6	2	Carbon black (F. W. Devoe & Co.).	Slow	85	*d*
7	2	Durable metal coating (E. Smith's varnish)	Slow	75	*d*
8	2	Black manganese (iron paint)	Fast	90	*f*
9	2	Carbonizing coating (trade mark)	Slow	80	*a*
10	4	Mineral rubber (no particulars).	Fast	78	*g*
11	2	Black (composition not given)	Medium	58	*h*
12	2	Carbon (no particulars)	Medium	92	*a*
13	2	Graphite (Standard Oil Co.), Kind not stated.	Medium	67	*a*
14	2	Graphite (Dixon Co.). Kind not stated	Slow	70	*d*
15	2	Asphaltum (California Co. brand)	Very slow	65	*j*
16	2	Rubberine (trade mark). Composition unknown	Medium	58	*k*
17	2	Black diamond (trade mark)	Medium	70	*l*

a Very little rust. Paint crumbles in places as though rotten. Easily removed.
b Fair condition, but discolored; rust coming through.
c Very badly rusted.
d Rusty, but not deep.
e Slight rust on top flange of one girder; rest of girder clean.
f Rust very deep; buckle plates bad.
g Area of rust spots small; rust not very deep.
h Rust very bad and deep.
j Deeply rusted; buckle plates still good.
k Rust very deep and angry; buckle plates mildewed.
l Small pimples of rust, as though formed under the paint.

cent), in which red lead formed one of the pigments in the paints, were no doubt destroyed by the action of hydric sulphide in the combustion gases from the locomotives, changing the lead oxide to a sulphide, with an increase of volume of about 33 per cent. This action will be given in more detail hereafter. The difference in the ratings being due to the greater amount of lead in No. 3 than in No. 1, and the higher rating of No. 1 was in no measure due to the menstruum, but solely to the smaller amount of lead. It is quite probable that the coatings on panels Nos. 9, 12 and 13, whatever the pigments might have been, were mixed with oil-carrying lead driers in excess, which would be attacked by the hydric sulphide the same as if the lead oxide was in the pigment. This change in an oxide or carbonate of lead is effected by an inexorable chemical law whenever they are exposed to hydric sulphide, and should have been foreseen by the chemists of the paint firms interested.

19. Panel No. 10, with four coats of a quick-drying paint, was evidently an asphaltum paint, with either benzine or bisulphide of carbon as an extra drier. Had only two coats of this paint been applied, its condition would have rated as low as panel No. 8, and, taken in connection with the other paints that had asphaltum as the base pigment, showed the same unreliable results which have attended the use of asphaltum compounds wherever they have been exposed to anything beyond the most ordinary conditions of service upon minor structures. See Toltz's and Smith's tests further on.

20. Panels Nos. 11, 15, 16 and 17, whatever their ratings from their outside surfaces, showed a worse condition of the metal beneath the coatings than any of the others. A greater or less amount of asphaltum in their pigments, compounded with other equally unreliable substances to form the basis of a patent or trade mark, is probably the cause of their low merit as given in this case. There is but little doubt that the majority of the persons interested in the several paints applied to this structure gladly welcomed the closing act in this test, when, shortly after the receipt of Mr. Seaman's report, the Board of Public Works gave the order to repaint the whole structure; which was done with (to the writer) some unknown paint, applied over the several test coatings in place without removing, except in the most perfunctory manner, the old coatings with their fast-forming burdens of rust, and the competitive test came to an end. The result could have been foreseen from the first, before a single truss or pound of material had been placed in position or was even out of the construction shops, had not commercial greed, official indifference or ignorance, either one or all, ruled the matter.

21. The destruction of the tubular railway bridge over the St. Lawrence River, at Montreal, Canada, had not become a fact so musty with age as to have escaped attention confirming the dangerous effect of hot combustion gases upon any paint coating in a confined space. Corrosion history blindly repeated itself when the viaduct material was first painted by the contractors, then repeated the "Comedy of Errors" when it was erected and again when it was sand blasted for its final fiasco. The plain facts of the painting after the sand blast action are, that the coatings were destined for an early destruction from the first, by reason that the first coat was applied in an atmosphere saturated with the hot vapors of combustion and steam which were so corrosive that the freshly cleaned surface of the metal showed a blush of rust within an hour after cleaning, and if left for three hours the rust could be wiped off by the hand. The paints were spread in this atmosphere, and before they could in any measure dry, so as to be in any degree resisting, they were thoroughly impregnated by the hot gases and steam which left their condensed strength upon the surfaces of the green paints. The second and subsequent coats were not only applied under the same atmospheric conditions as to the hot vapors and cinders, but had the condensed products of combustion sandwiched between them. Probably a baked japan or Bower-Barff coating are the only ones which would have successfully met the situation, which is an exceptional one. Such coatings would not have cost one-half as much as the sand blast and the several coatings applied in the first and subsequent stages, and would have been thoroughly protective and avoided nearly all the future expense in the care of the structure so far as the painted surfaces are concerned. It is to be hoped that the many engineering structures now in progress in and around New York city will receive a more effectual treatment for their protection from corrosion than has thus far been accorded to any such structure in the past.

22. Inspection of work in progress shows quite as great a disregard of all the essentials to secure even a temporary protection from corrosion as any of the earlier methods for this purpose, the disastrous results of which are forcibly recorded in Brunel's tubular bridge across the St. Lawrence River at Montreal, the trusses of the Brooklyn Suspension Bridge, the New York City Elevated Railway, and many other important structures, hardly one of which presents a good example of protection from corrosion under even ordinary atmospheric exposure. Scores of tons of material, piled at many points along the line of the Rapid Transit Tunnel, show mill-scale plentifully present on the principal members of the columns, girders, and other parts, all painted over. Many parts, indifferently closed by the rivets, show them to be unpainted on their inner surfaces, and are of such construction that it is now impossible to coat their inner surfaces even by the action of a force pump. Hundreds of minor parts are painted in so careless a manner that the protective coating is but little better than a wash of brick dust; the curdled appearance of some of the coatings clearly indicating that the red lead paint had set before its application, and that the pigment is of an inferior quality. The greater part of this steel work is to be placed where it will be always damp or so walled in as to be inaccessible for inspection, or else exposed to an atmosphere always charged with tunnel vapors, with what effect upon its resistance from future corrosion the experience of the past can give but one answer. Surely if the Boards of Admiralty of all the nations in the world deem the removal of mill-scale from the frames and plating of a hundred-ton steam tug of importance enough to resort to the pickling process for its removal before painting, those who are responsible for not only the construction, but the future condition and life of a $30,000,000 tunnel could afford to adopt some better method of guarding the work against the disastrous results from future corrosion than that as now evidenced. The hydric sulphide in the combustion gases from the locomotives in use in any part of the completed tunnel, pending the inauguration of the electric motor power, will reach and destroy the red lead pigment regardless of what coating it is in, or in whatever amount it forms a part.

23. It costs as much to spread a poor paint over a structure as a good one, and the labor is generally from two to four times the cost of the paint. There is not difference enough in the covering power of different paints to allow it to be any factor in deciding between them. All paints will spread over about the same number of square feet of surface if they are of the same body or weight per gallon, and the same care is used in brushing them out, but the *hiding power*, or power to cover up a poor job on the part of the painter, or to mask the effects of corrosion already in place, lies almost exclusively in the iron oxide paints. Given a ferric structure to be protected from corrosion, the several parts after the machining processes and assembling in their relative positions in the workshop, and before a single rivet is driven or a bolt placed permanently in position, all scale, loose or tight, that the scraper, hammer, chisel, or steel brush can remove *should be removed, not scratched at*, better yet, sand blasted. The latter need not cost over one-half cent a square foot of large and small surfaces, and this process would remove the dirt and grease due to the machining processes. It is the painter's custom to brush the grease with benzine and spread it over a larger surface, and as the mixture is not wiped off dry with waste at once it dries down again, and the evil is only increased, the effects of the benzine on the surface aiding the evil. Turpentine is a better solvent agent than benzine, but that must also be *wiped off*, not allowed to dry down mixed with the grease. No paint applied over a grease coating will ever bond to the iron. The writer has removed skins of good elastic paint coatings as large as the hand from important members of a truss which had been coated over with machine grease for a number of years. Such places are a fruitful cause of corrosion, particularly pitting, as they are likely to be found in inaccessible places like the inside surfaces between tension tie bars, etc.

24. The first paint coating applied at the shop should be done in a dry, clear, warm atmosphere, either under cover or in the sun. Never paint iron in a fog or with frost in the pieces, even if to the eye they look dry. Glue applied to the warm surfaces of wood is 10 per cent stronger than when applied to cold surfaces, and so will any paint cover and bond to the iron better if the surface is warm. The permanency of white lead mill marks on iron plates is due to this cause alone. It is a matter of no importance what the color of the first coating is, so that it is the *best* in quality of all those that are subsequently applied. A pure lampblack (not ground soot or bituminous coal) with boiled linseed oil can be ground and mixed for a light or heavy priming coat with the most satisfactory results in the protective qualities. This is true also of red lead and lampblack, a chocolate colored mixture, the two pigments uniting and working together when ground in the boiled oil as hardly any other two pigments are capable of doing, and there is hardly any other paint in which it is easier to detect adulteration. A small percentage of zinc oxide pigment works well with this red lead and lampblack mixture, and does not detract from its protective qualities for either wood or iron surfaces. It is probably as good a compound paint as can be mixed from a number of pigments not united as one body in its natural condition, but the influences to which any paint will be subjected must receive as much consideration as its composition. All paints containing red lead are extremely sensitive to the action of hydric sulphide, or the combustion gases from coal, as detailed hereafter.

GRAPHITE PAINTS.

25. The natural amorphous graphite pigments, particularly the Lake Superior brands, are distinctive in color, grind fine and granular, are amorphous in character, and indestructible as any pigments can be. They are wholly self-supporting as pigments, carry no elemental substances which tend to reduce them to a lower plane by oxidation or to slack in the presence of moisture. They require no body stuffing either to bond them or to keep them quiet, or from curdling or crawling during or after application. They are entirely different in character and composition from the many so-called silica graphites of commerce, compounded of flake graphite of more or less purity and of uncertain character with barytes, silica, furnace slag, and other substances. The several substances, even if the elements are non-corrosive, or non-oxidizable, or if they are electrically or chemically passive of themselves or collectively, when assembled as a pigment, are not as reliable or effective in a pigment as the same substances incorporated together by the processes of nature, each and every particle of which is of the same physical and chemical nature and equally affected by the menstruum, atmosphere or other conditions that affect a paint.

26. The silica graphite compounds have not the merit of being synthetical compounds, but are purely an agglomeration of substances as heterogeneous in character, with as many different specific gravities as the contents of a spoil bank or gravel pit can furnish. Many of these silica graphites are composed wholly or in part of carbonaceous schists, similar to soapstone and quite as repellent to the oil menstruum.

27. No human care in the mechanical processes due to the grinding, bolting, and mixing of the several substances in a compound pigment, can arrange them in sequence in either the pigment or paint. The flake graphite is hard to grind other than in a flake form, the silica, barytes and furnace slag are crystalline or vitreous in character, and grind and bolt as splinters or needles rather than in a granular or cubical form (the ideal form for a pigment atom), and have a tendency to mix with the oil in individual or by chance groups, instead of in a symmetrical whole as one natural granular compound substance would do. The flake graphite atom is a lubricant and is almost as repellent to the oil as it is to water, and does not carry well in the oil. The higher the percentage of carbon in the graphite the more these difficulties are developed. It is difficult to get hot glue to bond to a 90 per cent graphite. It is one of the lightest pigments, specific gravity, 2.38; while zinc white is 5.42; white lead, 6.43; red lead, 9.07; oxide of iron, 3.8 to 5.3. The experience of master painters and paint chemists points to the fact that pigments of the greatest density have generally proven to be the most durable. Flake graphite is hard to brush out alone in a paint, and the splintery character of the other substances assembled with it only increases this difficulty, as painters notice and complain about in the extra wear of their brushes, and the small area covered in a day's work. Flake graphite is easily adulterated with soapstone, specific gravity, 2.7. Neither the eye nor touch can detect the adulteration in a pound of flake graphite ground with three pounds of soapstone—analysis only will show it. As well expect a paint compounded of powdered glass and soapstone to be durable, as some of these so-called silica compound paints.

28. The natural drying of linseed oil in a paint or varnish is in the form of a closely woven web of a fine fabric. This shows plainly on the surface of a freshly dried or drying surface, and explains the reason why two or more coats are necessary to give a smooth foundation for the last or finishing coat. Each subsequent coat fills the interstices of that underneath it, the several coats mutually repairing the other's deficiencies, as successive folds of a fine muslin will, in the aggregate, make an adequate covering from heat or light. Now it is the function of a pigment to fill these cellular formations in the drying menstruum, or rather, while being applied together with a brush, for the atoms of a pigment mechanically arranged by the brush to lie side by side, all imbedded in the oil, which in drying naturally takes the lines of least resistance, i.e., between the atoms of the pigment, so that, as it were, each atom lies in an approximately square hole, which is the most favorable condition for the bond between the pigment and its vehicle. But if the atom of the pigment be splintered like a sliver of glass, or of only length and breadth like a flake, then the natural cellular formations of the drying menstruum cannot be realized, and such pigments arrange themselves with the sharpest angles and edges upright to the drying surface, and are not well covered in or imbedded in the oil. Hence they dry with a rough surface which holds moisture and dust which decomposes and quickly disintegrates them from their bed, and more moisture, cinders, and dust take their place to repeat their cycle of action on the atoms in the coatings beneath. A round marble does not bed itself as strongly in a cement as the cubical block from which it is made, neither does a beach-worn sand or a quicksand atom, with the best of cement paste, make a good mortar, for the same reasons.

29. An interesting contribution to the literature of protective coverings for iron is to be found in a pamphlet published by the Railway Car Journal, New York, 1896, being a translation from the German of a Prize Essay by Prof. J. Spennrath, under the auspices of the Society for the Advancement of the Industrial Arts, Berlin, Prussia. Some of the conditions and causes which lead to the destruction of paint coatings were reproduced by Prof. Spennrath in his laboratory experiments, but these only simulated the conditions of a paint exposed to actual service on a structure. Nineteen of the twenty experiments were with a *chemically prepared pure flake graphite* as a pigment, mixed with boiled linseed oil, presumably also chemically pure, though the professor is silent upon that point. The experiments were made on the paint skins as removed from the metallic plates on which they were dried, and were conclusive that certain acids and gases would destroy the menstruum of a paint skin coating of graphite and oil, but what the effect of these would have been had the skin not been removed from the metal is not stated. The professor, evidently, from the paragraphs preceding the record of his tests, had found the action of a coated metallic plate essentially different from that of a paint skin detached from its

bond on the plate, and so far as the pigment was concerned in its relation to the oil as a protection from corrosion, the experiments might as well have been conducted with dried oil coating alone. The professor's experiments with the action of heat upon paint skins of various composition are quite as inconclusive of what to do to protect our ferric structures as his other reported chemical experiments. We do not expect our paint coatings to take the part and form of a loose tarpaulin covering, or to require an umbrella covering to protect them from the sun. There are many commercial paint and varnish compounds which successfully resist nearly all of the destructive elements detailed by Prof. Spennrath, and it is to be regretted that his experiments did not embrace some of them, instead of the one flake graphite pigment he used, which cannot be had for a dollar a pound.

(To be continued.)

GLYCERINE TEST.

GLYCERINE produced directly from oils and fats is known as glycerine of saponification (soap-making glycerine). It ought, for commercial purposes, to have a density of 1,240, and after evaporation and calcination of the residue to leave not more than 5 thousandth parts of ash, incombustible and dehydrated matter.

The test of density requires troublesome methods, but this is not the case with analysis of the ash.

The results in various commercial laboratories with identical samples seldom agree; they often differ from 20 to 30 per cent.

The following is usually the process: 10 grammes of glycerine evaporated in a platinum capsule. The tarry residue is burned in the air, leaving a new residue consisting of carbon and various salts.

To completely consume the carbon the temperature must be raised to a high degree. The alkaline sulphates, chlorides and carbonates which are generally contained in the residue become fused and volatilized at their respective volatilities, provided the heat is not too intense or too prolonged. The alkaline chlorides may even disappear altogether before the carbon is entirely consumed.

As the temperature is measured by the eye of the operator the great difference in results is not strange.

It is time to adopt a method more exact. The one we employ in our laboratory required a little more time, but has all the simplicity of the former process.

The glycerine is evaporated as before. The tarry residue is pulverized and burned; 5 to 6 c.c. of distilled water is poured upon the spongy residue; after standing for a moment the clear solution is drawn off by means of a pipette with a capillary beak, which does not allow the particles of residuary carbon to pass. The pipette is made by drawing out a tube in a flame and the attenuated portion is broken off at the desired point for a small aperture.

It is washed the second time, using not more than 10 to 12 c. c., and the solution preserved.

The contents of the capsule are dried and calcined at a temperature which causes the carbon to disappear.

In that residue deprived of soluble salts the calcination is very rapid, and the disappearance of the carbon almost instantaneous.

When cooled the water used in washing is added to the residue and evaporated with the usual precautions.

After it is thoroughly dried, the temperature is raised to a dull red over the flame of a Bunsen burner for a few seconds.

By the above method the results are constant and exact to nearly the ten-thousandth part.—From the French of Calixte Farrier, in the Moniteur Scientifique.

SOLUTION OF TAR OIL FOR THE IMPREGNATION OF WOOD, PREPARED BY M. RÜTGERS.

IN a machine of transversal movement, mix 100 parts of resin oil, cold, whether crude or refined, with 100 parts of sulphuric acid containing a little anhydride. After the liberation of a small quantity of sulphuric acid, the resin oil is dissolved in the sulphuric acid. An almost homogeneous mixture is formed of sulphuric acid, and the acids of resinous compounds of ethers, which is dissolved by the addition of limited quantities of water. Two layers are obtained, the lower one formed of dilute sulphuric acid, and the upper containing nearly the whole of the compound acids, with very little free sulphuric acid, and the resin oils which are not dissolved. On heating, then, for some time, the separation of small quantities of acid is effected; the upper layer is neutralized with the liquor, moderately diluted, of soda or potash, and water is added in quantity to form about 200 parts. The liquid, which is but slightly clouded with small quantities of the separated substances, is mixed with an equal quantity of tar oil, and water is added for the required degree of dilution for the impregnating liquid.

It is still more advantageous to proceed in such a way as to add to the free acid of compound ethers, before neutralizing with the alkali, an equal or larger quantity of tar oil. By then adding limited quantities of water, the separation of all the remaining free sulphuric acid is effected, so that all formation of alkaline sulphates and their hurtful action on the solution of tar oil are prevented. The neutralization and the addition of the necessary water are then attended to.

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